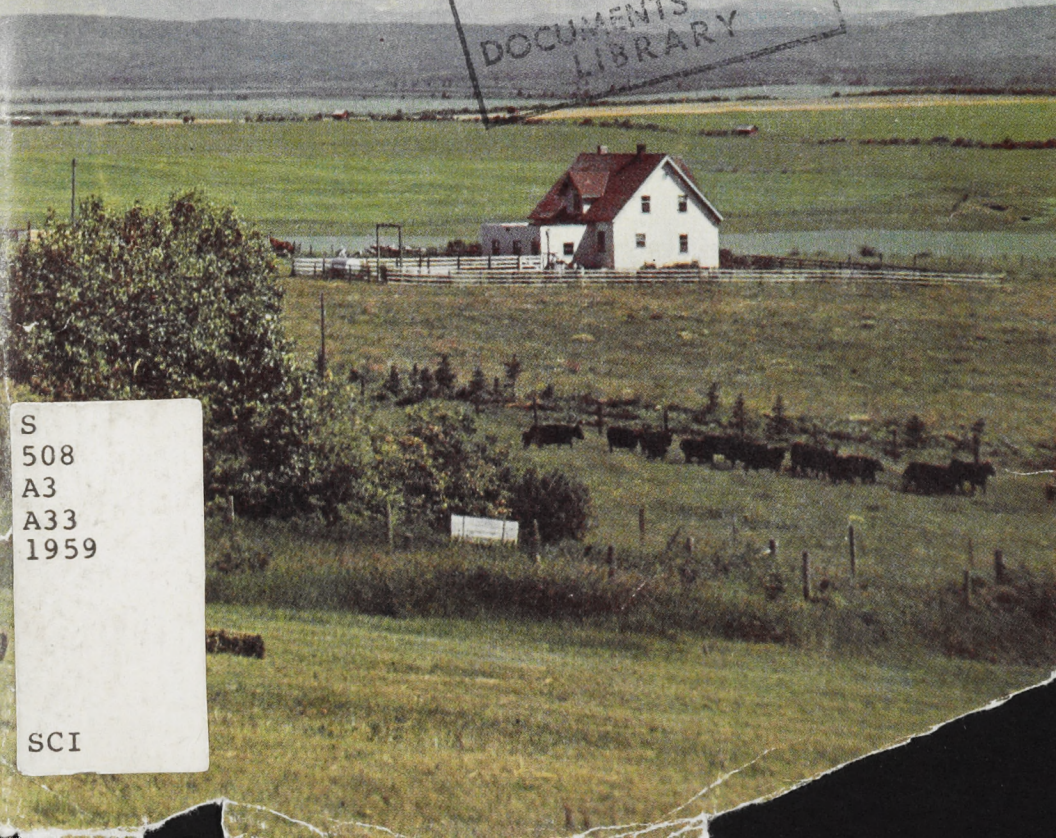
ALBERTA FARM GUIDE



1st issue 1959

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Prepared by representatives of:
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THE CANADA DEPARTMENT OF AGRICULTURE
and
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HON. L. C. HALMRAST
Minister

FOREWORD

The Alberta Farm Guide has been published to co-ordinate and consolidate a wealth of information for the use of farmers. It is intended to replace some of the publications dealing with specific subjects. It will provide a brief reference on a wide range of topics, but is not intended to meet the needs of farmers requiring extensive information on any specific phase of agriculture.

The Guide presents recommendations which have been approved by the technical agriculturists in Alberta and is based on the most recent information available. The material has been prepared under the general direction of an Editorial Committee and seventeen Subject Matter Committees comprised of officials from the contributing agencies. It is planned to revise the publication every three years.

The publication of this Guide is financed jointly by the Canada Department of Agriculture and the Alberta Department of Agriculture.

Contents

Climate

The climate of Alberta is predominantly continental. Most of the air circulating over the province comes either over the mountains from the west or from the north and northwest by way of the McKenzie Basin. Alberta is located too far to the west to receive, to any significant degree, the very warm air from the Mississippi Basin which frequently penetrates northward into Saskatchewan and Manitoba.

The mountains modify the climate. Air from the west may bring a chinook, while the cold air from the north is steered eastward by the mountains so that modification of cold takes place in Alberta before it occurs to the east.

At the same latitude the western parts are warmer in the winter than the easterly portions. While in the winter the temperature gradient from south to north is considerable, in the summer it is very slight. Summer temperatures do not limit crop production in the northern areas as much as might be expected.

Most of the more prolonged and widespread rains are caused by the warm Pacific air crossing the mountains and converging with the drier, cooler air from the north. This Pacific air is comparatively dry after crossing the mountains, but on rising, it becomes chilled and its moisture falls as rain. Some of the more extensive rains in the south and eastern portion may be due to a similar association of warm, moist air from the Mississippi Basin and cold Polar air. Heavy showers in summer are often caused by air being warmed on passing over the land. Such air becomes unstable, rises, cools, and loses its moisture as rain.

WINDS

Because of chinooks and blocking or steering effects of the mountains the wind pattern is complex. Winds may vary markedly in speed and direction over short distances. The southwestern part of the province is the windiest. (see "Wind Erosion" p. 17.)

The strong, warm winds which blow out of the mountains are known as chinook winds. The chinook gains its warmth from compression in descending the mountains. The chinook is dependent on a gradual slope to the mountains and the winds must attain a minimum speed. There are, "positions" or "tracks" where the winds burst forth at high speeds (30-40 m.p.h. is typical) and fan out to the eastward. Speed is lost rapidly, so that at about 100 miles from the mountains the chinook tends to lose its characteristics, although the warm air is often carried far to the east.

Chinooks occur most often in fall and early winter and again in early spring, and least in summer. They are most frequent in the southwest, much less frequent north of Calgary and again rather common in the upper Peace region. In all western sections, they occur often enough to affect the climate.

In summer, chinook winds tend to be cooler, but can damage crops because of their dryness. One of the most significant aspects of the chinook is the way it removes snow. This increases winter killing of certain plants, but, increases the length of the grazing season.

The removal of snow increases soil erosion by wind. This is a serious problem in the Lethbridge-Ft. Macleod area.

Rapid changes in temyperature may be accompanied with blizzards which are violent in the prairie sections.

SOLAR RADIATION

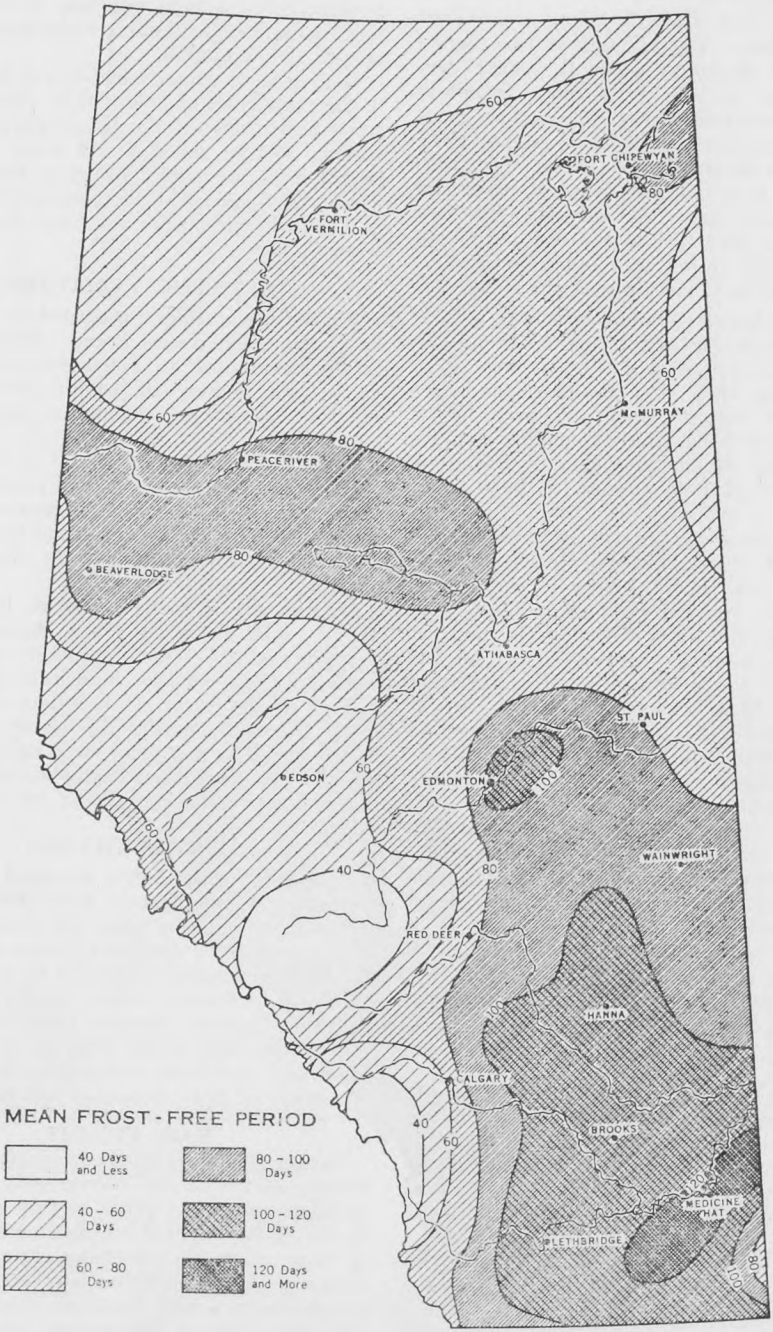
Alberta being well to the north, the midday sun is relatively low, particularly during winter. In summer, Alberta usually receives adequate sun energy. At this season there is only slight difference in the amount of solar energy received from south to north in the province long days in the north compensating for the low declination of the sun. Alberta loses a great deal of its sun energy or warmth in the winter because of the high reflecting power of snow.

Although Alberta's supply of sun energy may be sufficient in summer, temperatures too cool for adequate crop growth frequently prevail. This is because daily temperatures are determined by the warm and cold air masses that continually circulate over the earth and Alberta is much exposed to cold air masses from polar regions.

Plant development, i.e., time of heading, flowering, etc., is influenced by the length of day from sunrise to sunset. Long days stimulate many of the crops grown in Alberta to develop rapidly resulting in early maturity.

TEMPERATURE

On clear, calm nights when the official thermometer is near freezing there may be frost at crop levels. The map on page 5, showing the average period in days between the last frost of spring (32°F) and the first frost of fall, is based on recordings obtained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FORT CHIPEWYAN
80
FORT VERMILION
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McMURRAY
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PEACE RIVER
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BEAVERLODGE
ATHABASCA
ST PAUL
EDSON
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EDMONTON
100
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40
80
WAINWRIGHT
RED DEER
100
HANNA
CALGARY
40
60
BROOKS
MEDICINE HAT
LETHBRIDGE
80
100
MEAN FROST-FREE PERIOD
40 Days and Less
40 - 60 Days
60 - 80 Days
80 - 100 Days
100 - 120 Days
120 Days and More

from thermometers placed in louvered screens 4 feet above the ground.

A killing frost is usually taken as any frost 28°F or lower. The killing-frost-free period is usually 3 weeks to a month longer than the frost-free period. It is more important than the frost-free period insofar as grain crops are concerned as in many stages these crops are not injured by light frosts. The frost-free period is significant for small fruits and tender garden crops. Actually the frost-free period at any particular spot is very dependent on topography. In northern and western areas, the low spots may have frost at any time.

Regions having similar frost-free periods are outlined in the accompanying map. The seasons become shorter north and west from Medicine Hat, with the exception of the upper Peace River region which enjoys a longer frost-free period than the surrounding area. A detailed map would show innumerable variations in all districts because of local topography.

The Meteorological Service of Canada issues warnings of spring and fall frosts in radio broadcasts . On a day before a night frost, temperatures are lower than normal; cloud prevents the sun from warming the surface, and toward evening the sky clears and the wind drops. If, the surface is wet, a damaging frost is less likely to occur.

The altitude of Alberta shows a general decrease from south to north. This condition tends to balance the cooling effect associated with northern position. Elevations are 950 feet at Fort Vermilion, 2200 at Edmonton, 3400 at Calgary and 3000 feet at Lethbridge.

Frost penetration is of minor importance from the standpoint of overwintering crops. Frost may be expected to penetrate to a depth of 5 to 7 feet in a soil with no snow cover on the the prairies and usually reaches at least 4 feet. In the central and northern parts it may penetrate 8 feet deep.

PRECIPITATION

The map on page 7 outlines the regions with similar average annual precipitation. Precipitation is greatest along the foothills, diminishing rather rapidly toward the east and gradually toward the north. Most of the area devoted to agriculture lies in those regions receiving from 12 to 20 inches.

Limited data suggest that the highest intensities of rain in the province occur in the Olds, Lacombe, Three Hills area.

Water loss by evaporation from the soil plus that consumed or transpired by crops is termed "evapotranspiration." Districts receiving the same rainfall may have quite diferent "moisture regimes" because of difference in rate of evapotranspiration. A high rate may be caused by much wind, much sunshine, warm temperatures as well as low rainfall.

In most years winter snowfall is of little value in the production of grain crops. Much of the snow water runs off the frozen ground in the spring. Winter snowfall and cover are more important as protection for over-wintering crops. The wooded and parkland areas are more favorable for the production of crops sensitive to winter injury.

CLIMATIC VARIATION

Agriculture in Alberta is carried on very close to minimum climatic conditions. While average weather conditions are favourable, extreme deviations are so frequent that the production of the common crops becomes a risky undertaking.

Rainfall variability is greatest in the prairie region, somewhat less in the parklands and least in forested areas. In all regions monthly precipitation varies more than the annual; variations being most frequent in the summer months.

The hazard of frost is generally high where the drought hazard is low. Hence, on the western and northern fringe, late spring and early fall frosts increase the risks of agriculture.

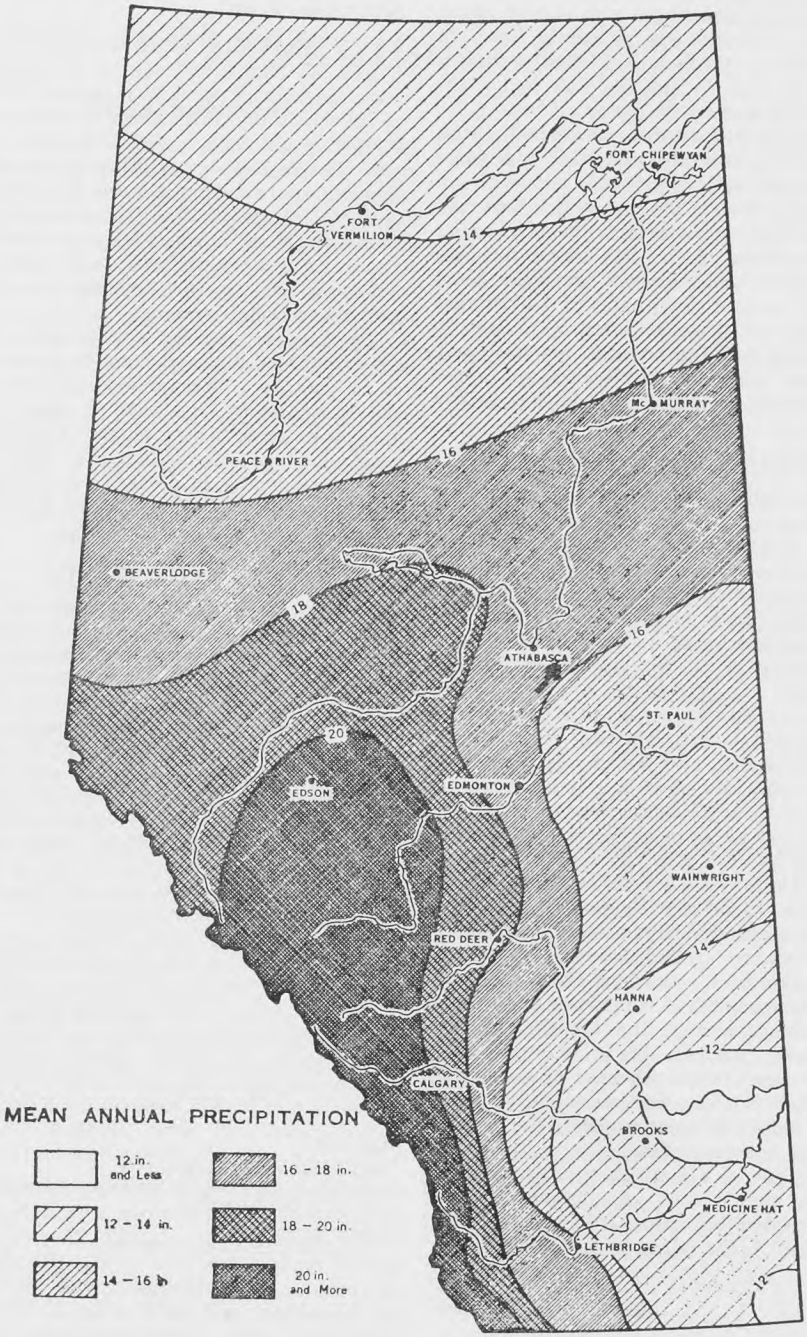
Late spring frosts do not limit agriculture to the extent that early fall frosts do. The danger from fall frost is great when ripening is delayed. In lesser degree, early seeding reduces the chance of the crop being injured by fall frost.

WINTER KILLING

In Alberta winter killing is caused by: 1) the drying out of the plant by warm weather when soil is frozen, 2) the plant not having time to change to winter dormancy before winter, 3) breaking of dormancy followed by winter weather, and 4) freezing within plant cells as opposed to freezing between plant cells. This last occurs with sharp drop in temperature. "Heaving" and plant suffocation by ice sheet formation are not common in Alberta.

HAIL STORMS

Summer hail usually accompanies thunderstorms, though on the average only about one thunderstorm in six yields hail at the ground. In the spring and fall seasons, small hail, ice- or snow-pellets are sometimes observed during showery weather without any accompanying thunderstorm. Hail becomes more frequent and destructive as the summer advances, the peak being reached in the later part of July and early August.


FORT CHIPEWYAN
FORT VERMILION
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Mc MURRAY
PEACE RIVER
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BEAVERLODGE
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ATHABASCA
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ST. PAUL
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EDSON
EDMONTON
WAINWRIGHT
RED DEER
14
HANNA
12
CALGARY
BROOKS
MEDICINE HAT
LETHBRIDGE
12
MEAN ANNUAL PRECIPITATION
12 in. and Less
16 - 18 in.
12 - 14 in.
18 - 20 in.
14 - 16 in.
20 in. and More

Long-term insurance records indicate three or four major hail paths across central and southern Alberta running approximately west to east. However, there is sufficient variation from year to year to indicate that hail paths cannot yet be accurately plotted.

There appear to be two types of hail storms in Alberta. One is the sporadic, individual storm scattered and short-lived, and with no well-defined pattern to the hail, which is usually spotty and light. The second type, the major destructive storms which often travel over one hundred miles and produce damaging hail almost continuously along paths of 4 to 6 miles wide. While these major storms are usually frontal, occuring at the break of a warm spell, considerable hail may develop in the cooler squally weather immediately following such a break.

WEATHER MODIFICATION

Weather modification is not new, having been practiced for many years by fruit farmers, by the use of orchard heaters, circulating fans, etc. In recent years, rain stimulation and hail suppression have become identified with weather modification. Both involve the delivery into the cloud of a suitable material (usually silver iodide) generated at the ground or released from aircraft.

In rain stimulation, seeding is to promote the appearance of ice crystals which, after growing as snow-flakes melt and fall as rain. Summertime rain, may also develop, independent of ice crystals, in which case seeding with salt particles might be more successful. Evaluation of the success of a rain stimulation project is difficult, due to the variability of natural rainfall. While significant increases in rainfall have been stimulated in the coastal regions of the northwestern United States, results have not in general been conclusive elsewhere.

The principle of hail suppression, as at present practiced, is that the "freezing-out" of cloud masses prevents the growth of hail to damaging size. Present theories of hail formation suggest that the necessary concentration of silver iodide are not possible except with more ground generators than are currently used. The evaluation of hail suppression is more difficult than that of rain stimulation since hail is more variable than rain. It has been claimed that "seeded" hail tends to be soft and "mushy;" however, soft hail has been observed well outside seeded areas.

SEASONAL FORECASTING

Reliable long-time forecasts of weather patterns are still not possible. However, knowledge of the winds and their effects on future weather is steadily increasing. The United States Weather Bureau now issues thirty-day forecasts of precipitation and temperature departures from normal, for practically the whole of North America. These forecasts have been sufficiently successful to warrant their use by agriculturists although they are too general to be of much use to individual farmers.

Contrary to popular opinion the longer a dry, wet, a cold period lasts the more likely it is to continue. Examination of the climatic data for Alberta has failed to show that the rainfall of the growing season is preceded by particular types of weather. Wet summers occur as frequently as dry after a fall or winter with heavy precipitation or after a winter with lower than normal temperatures.

CLIMATIC TRENDS

The most reliable information on the departure of the ice age from our prairies sets the time at 10,000 years ago. The ice melted apparently because of a trend toward warmer weather over a period of several thousand years. Geologists have estimated a rise in mean annual temperature of about 10°F. since the last ice age, or an average of one degree in 1,000 years. For the agriculturist, whose brief span is reckoned in years, there is little point in referring to such trends. We would be foolish to believe that a series of wet years indicate a trend or that a series of violent storms is a result of atomic explosions.

The dry period in the 1930s and the long series of wet years thereafter were good examples of the variability to be expected in our weather pattern. No one yet knows how to predict the weather for the next ten years because detailed study of the data does not reveal any definite cycles.

References:

Meteorolgical Office, Toronto
Vol's I, II, III—Climatic Summaries of Selected Stations.
Atlas of Canada ($2.00).

Queen's Printer Ottawa
Climate of Central Canada ($1.00).

Soil Zones and Fertilizer Recommendations

Soil Zones

The soils of Alberta have been divided broadly into several major soil zones as shown on the Soil Zone Map. These have been described in a number of published papers and soil survey reports. From the relatively dry Brown soil zone of south eastern Alberta the moisture efficiency increases and the climate becomes progressively more humid towards the west and north, and this has had a profound effect on the native vegetation and the character of the soils.

The semi-arid Brown prairie soil zone of south-eastern Alberta covers about 12 million acres. The surface soil horizon is generally light brown to brown in color. This is a short grass prairie region, and only the heavier or drought resistant soil types in this zone can be considered arable, except in districts where the soil is irrigated. Most of the area is desirable for ranching. This soil zone is not very favourable to the growth of legume crops such as clovers and alfalfa, except under irrigation. Moisture is the major limiting factor in crop production and fertilizers are not generally recommended for dry land farming.

North and west of the Brown soil zone lies the Dark Brown and then the Thin Black soil zone, approximately equal in size and together covering about 15 million acres. The surface horizon of the former is generally dark brown in color and the upper 3 to 6 inches of the latter are generally black or very dark brown. These are grasslands partially invaded by trees, mainly deciduous. Wheat is the principal crop grown but considerable diversification is possible. Legumes such as sweet clover and alfalfa can be grown successfully on these soils, and in addition to grasses, should be more widely grown to maintain the soil nitrogen, organic matter and fibre content. These two zones are considered together from the standpoint of fertilizer recommendations in this publication.

The Black and Degraded Black soil zones of central Alberta and the Peace River region cover about 10 million acres. They consist of grasslands partially invaded by trees, mainly poplar. In this publication these zones are considered together from the standpoint of fertilizer recommendations. The black soils have a black to very dark brown surface layer that averages about 12 inches in depth. The degraded black soils have a grey leached layer near the surface, but are nevertheless relatively fertile. These comparativly deep black soils are rich in total organic matter and nitrogen, but they often respond to applications of available nitrogen and phosphorus. Legumes and grasses can be grown successfully on these soils and should be included in rotations with cereal crops.

The Grey Wooded soil zone lies west and north of the central Black soil zone and covers about two-thirds of the entire province, but it is doubtful if more than about 14 million acres are arable. The native vegetation consists of a mixed deciduous and evergreen woodland in which peats frequently occur. The undisturbed soil profile is usually characterized by a thin surface layer of semi-decomposed leaf litter above a severely leached and bleached greyish layer averaging 6 to 8 inches thick, and a heavier textured underlying horizon. The soils in this zone are very deficient in organic matter and nitrogen, often deficient in phosphorus, and in many areas, deficient in sulphur. It is essential to grow legumes such as clovers and alfalfa, or mixtures of legumes and grasses, in order to add nitrogen and organic matter to the soils.

Fertilizer Recommendations

FERTILIZERS AND PLANT NUTRIENTS

Plant nutrients are chemical elements which crops must ordinarily obtain from the soil and atmosphere in adequate amounts if they are to grow satisfactorily. A fertilizer supplies one or more plant nutrient elements, of which nitrogen, phosphorus, potassium and sulphur are examples. Farm manure, green manures, legumes and commercial fertilizers all are used to supply one or more of these elements in order to improve crop yields.

Of the essential chemical elements which plans must obtain from the soil there are four that are most likely to be deficient in Alberta soils. These are nitrogen, phosphorus,, potassium and sulphur. Each has specific essential roles in plant nutrition.

What nitrogen does:

—Gives dark green color to plants.
—Produces rapid growth.
—Feeds soil micro-organisms during their

decomposition of low-nitrogen organic materials.
—May increase yields of leaf, fruit, or seed.
—May improve quality of leaf crops.
—May increase protein content of food and feed crops.

What phosphorus does:
—Stimulates early root formation and growth.
—Gives rapid and vigorous start to plants.
—Gives winter hardiness to fall-seeded grains and hay crops.
—Often hastens maturity.
—May stimulate blooming and aid in seed formation.

What potassium does:
—Imparts increased vigor and disease resistance to plants.
—Produces strong, stiff stalks, and thus may reduce lodging.
—Essential to the formation and transfer of starches, sugars, and oils.
—Imparts winter hardiness to legumes and other crops.

What sulphur does:
—Gives increased root growth.
—Helps maintain dark green color.
—Promotes nodule formation on legumes.
—May stimulate seed production.
—Often increases protein content of alfalfa and clovers by 1/10 to 1/4.

Calcium and magnesium and the seven so-called trace elements all have their own specific roles in plant nutrition. However, tests to date have not yet found a general deficiency of any of these elements anywhere in Alberta.

Alberta soils in general appear to contain sufficient potassium. Responses to potassium have occurred only in isolated cases, mainly in peat fields.

Note—Some common names are widely used when referring to compounds containing the chemical elements supplied by fertilizers. Examples follow.

Chemical element	Some common names applied to compounds containing element
Nitrogen	ammonium; nitrate
Phosphorus	phosphate; phosphoric acid; phosphorus pentoxide
Potassium	potash
Sulphur	sulphate

FARM MANURE

Farm manure is one of the best fertilizers. It supplies not only plant nutrients, but it adds organic matter to the soil. This organic matter improves the physical condition of the land and helps it to hold moisture and resist erosion. Manure is rather low in phosphate, so phosphate fertilizers generally should be added.

On most Alberta farms there is not enough manure to supply all the fertilizer needed, but even a limited supply can be used to advantage. Spread over as large an area as practical, manure will give greater immediate returns per ton than if spread heavily. Usually it is better to utilize 30 tons on three acres than on one acre.

GREEN MANURE

Green manuring is another way to improve the soil. Immature cereal or legume crops worked into the land add organic matter. improve the physical condition of the soil and often increase the supply of available plant nutrients.

Green manures do not add any mineral that they have not previously taken from the soil but the supply of nitrogen may be increased by plowing under properly inoculated legumes. Inoculation introduces bacteria which, in association with the legume roots, change nitrogen of the air into compounds useful to both the bacteria and the legume. Cereal crops that follow also benefit from this increase of nitrogen in the soil.

Green manuring in Alberta should be limited to the following cases.

(1) On irrigated land, preferably using a legume.
(2) On grey wooded soils using a legume or a legume-grass mixture.
(3) On grain farms, where sweet clover is seeded with grain to produce a beneficial legume crop as a substitute for fallow after grain.
(4) In other areas of Alberta green manuring should generally be limited to legume and grass stands being broken up from hay or pasture.

On irrigated land and grey wooded soils the best results are sometimes obtained by plowing down the entire crop, but beneficial results are also generally obtained when the hay crop is removed before plowing. When the legume is plowed immediately after haying, the addition of nitrogen to the soil is not as great. The amount added is more or less proportional to the amount of legume plant material returned to the soil. It is probably better to cut the hay early, and, if moisture conditions are favorable, let the legume make some regrowth before plowing down. Immediate plowing, after haying, allows a longer fallow period during which reserves of plant nutrients and moisture can be built up, while deferred plowing allows an accumulation of organic matter and nitrogen,

which may have important long time effects on a soil.

A high analysis phosphorus fertilizer usually gives excellent returns on land that has been green manured with a legume.

COMMERCIAL FERTILIZERS

Commercial fertilizers are manufactured products that contain one or more plant nutrient elements. They supply in concentrated form the same nutrients that plants obtain from the soil. Used in accordance with recommendations in this Guide commercial fertilizers cannot injure the soil or crops in any way. A guaranteed analysis of the nitrogen, phosphorus and potassium content must be clearly indicated on the fertilizer bag or container. This ruling, provided under the Canadian Fertilizer Act, is for your protection and guidance.

WHAT'S IN THE BAG?

When buying a commercial fertilizer study the figures on the container and be guided by them. They may save you money. They show the percentage of nitrogen, phosphate and potash—and always in that order. For example, a fertilizer labelled 10-30-30 contains 10% nitrogen (N), 30% phosphate (P_2O_5) and 10% potash (K_2O). These figures show the major plant nutrients you are getting and with their help you can choose the fertilizer that will supply most economically the plant nutrient or nutrients you need. Most fertilizers also contain small quantities of other plant nutrient elements that may be beneficial to plant growth, but these are not usually shown on the container. Sulphur is such an element, and some of our soils in Alberta need this plant nutrient.

From the cost of fertliizers, the cost per pound for each of the various nutrients may be calculated as follows:

For nitrogen (N). One ton of ammonium nitrate contains 670 lb. of nitrogen (33.5% shown in Table 1). This is 335 lb. per 1,000 lbs. of fertilizer or 670 lbs. per ton. If one ton of ammonium nitrate (670 lb. of nitrogen) costs $81.00 then one pound of nitrogen costs approximately 12 cents.

Similarly with phosphate and potash—using the analysis shown on the bag it is simple to discover how many pounds of each element is present in a ton of the fertilizer. It is then equally simple to determine the price per pound of the element concerned.

In Table I, below, you will find the guaranteed analysis and the sulphur content of some of the fertilizers sold in Alberta.

TABLE 1
Information on Some Fertilizers Available in Alberta, 1959

Name of Fertilizer	Guaranteed Analysis N% (Nitrogen)	P_2O_5% (Phosphate)	K_2O% (Potash)	Sulphur content %
Anhydrous ammonia	82	0	0	0
Ammonium nitrate	33.5	0	0	0
Ammonium sulphate	21	0	0	25
Ammonium nitrate-phosphate	27	14	0	low
Ammonium nitrate-phosphate	24	20	0	low
Ammonium nitrate-phosphate	23	23	0	low
Ammonium phosphate-sulphate	16	20	0	14
Ammonium phosphate	11	48	0	low
Complete	10	30	10	5
Farm manure	0.5*	0.25*	0.5*	low
Liquid fertilizer	7	14	7	low
Potassium chloride (muriate of potash(	0	0	60	low
Potassium sulphate (sulphate of potash)	0	0	51	20
Gypsum (calcium sulphate)	—	—	—	18
Sodium sulphate (dry)	—	—	—	22
Sulphur (commercial)	—	—	—	98

* Plant nutrients in manure vary with the kind and age of the manure.

ANHYDROUS AMMONIA

This high analysis fertilizer (82-0-0) is a suitable source of nitrogen but special equipment is required since it is marketed as a liquid stored under pressure in special tanks. The liquid vaporizes on release of pressure and the ammonia gas produced must be applied by means of a special type of applicator, such as a chisel, which places it below the surface. Anhydrous ammonia application requires a separate operation sometimes, but this may be combined with soil tillage. The gas itself can be dangerous. Therefore it is essential that those working with ammonia know how to use and handle it safely. Operators should wear tight fitting goggles and rubber gloves when making adjustments to any parts of the equipment that are under pressure. Tests to date in Alberta and elsewhere indicate that pound for pound, the effect of nitrogen is the same whether it be in the form of 82-0-0, 33.5-0-0, or 21-0-0.

LIQUID FERTILIZERS AND FORTIFIED DUSTS

Tests to date indicate that liquid fertilizers available in Alberta as seed treatments are not effective or economical forms of fertilizers for grains. Liquid fertilizers applied with 2,4-D have not proved profitable for Alberta crops.

Foliar application of fortified dusts, leaf-feeding dust fertilizers or liquid fertilizers are not recommended at present, but experimental work with them is being continued.

SOIL AMENDMENTS

Soil amendments provide another type of soil improver. They may or may not act as fertilizers. Lime and peat are examples of these materials.

Lime may be used as a soil amendment to correct an acid condition of the soil. As a fertilizer it may serve to supply calcium. **Very few Alberta soils need lime.** If you suspect that your soil is acid, send a sample to the Agricultural Soil and Feed Testing Laboratory, University of Alberta, Edmonton, Alberta. A simple test will show whether or not lime is likely to be needed.

Peat may be used to improve the physical condition and moisture-holding capacity of grey soils and clay soils, and to improve moisture-holding capacity of other soils also. When properly worked into the soil, well decomposed peat has proved better for this purpose than coarse light-colored peat. Peatlands are found frequently in the grey wooded soil zone, but because of the labour involved application usually is confined to gardens, greenhouses and other small areas.

Farm manure is one of the best soil conditioners. Because of its value as a fertilizer, it serves two purposes at the same time.

Chemical soil conditioners are now available. As yet the cost is too great to make their use practical on a large scale. Greenhouse operators and home gardeners may find thsee chemical soil conditioners useful.

SHOULD I USE FERTILIZERS ?

In a well-managed farming program fertilizers can be a profitable investment but care must be taken to use the right kind and amount. The use of fertilizers does not of course guarantee a good crop. A good growing season with proper amounts of rain and sunshine are needed and the soil must be in good tilth. Fertilizer response thus varies from year to year.

Check the map to find the soil zone in which your farm is located, then read the recommendations for use of fertilizers in that zone. If in doubt consult your nearest District Agriculturist, Experimental Farm, or the University Department of Soil Science.

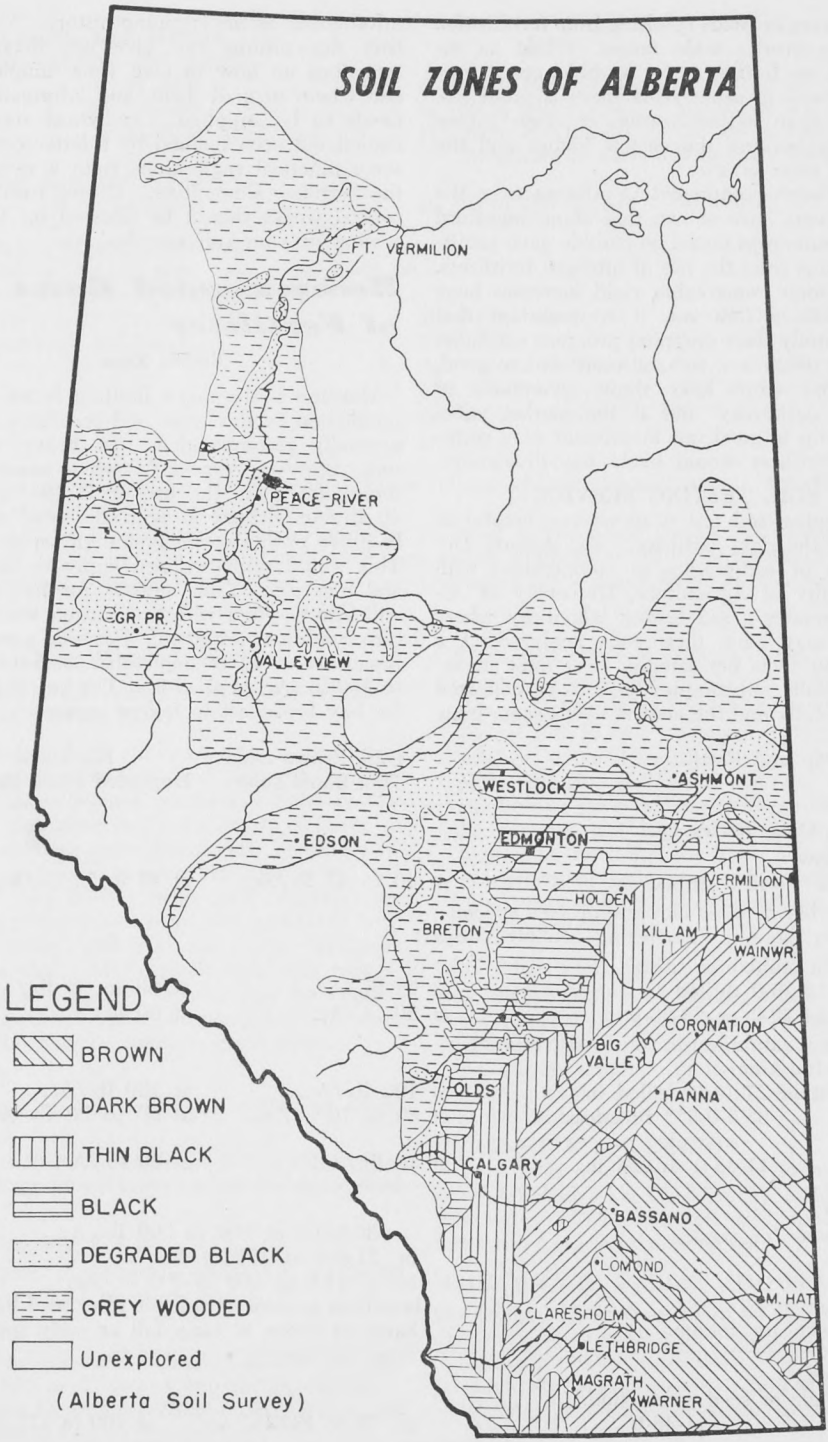
FERTILIZER PLACEMENT

The most effective use of a phosphate fertilizer is generally made when it is drilled in with the seed. Phosphate does not move readily into or through the soil so it must be placed within easy reach of the roots. Thus, when using a discer or one-way for seeding or when broadcasting fertilizer extra phosphate is needed to get the same results as when the drilled-in method is used.

Nitrogen on the other hand moves readily into and through the soil. Furthermore, there is a risk of seedling injury if too much is planted with the seed. For the coarse grains 30 pounds of the element per acre is considered the maximum safe application for nitrogen drilled-in at planting time.

FERTILIZING STUBBLE CROPS

Nitrogen is likely to be an important limiting factor in crops grown on stubble, particularly where there is a large amount of trash; phosphorus is almost certain to be in short supply. A shortage of nitrogen results in a pale green color or yellowish green color and a thin stand of crop. The appearance of previous stubble crops therefore should be used as a guide as to whether or not to use high nitrogen fertilizers. In the drier-parts of the province where fallowing is practised to conserve moisture it must be kept in mind that stubbled-in crops are more likely to suffer from drought. This, coupled with the fact that the response of a stubble crop to nitrogen depends to a large degree on the growing conditions, means that


SOIL ZONES OF ALBERTA
FT. VERMILION
PEACE RIVER
GR. PR.
VALLEYVIEW
WESTLOCK
ASHMONT
EDSON
EDMONTON
VERMILION
HOLDEN
BRETON
KILLAM
WAINWR.
CORONATION
BIG VALLEY
OLDS
HANNA
CALGARY
BASSANO
LOMOND
M. HAT
CLARESHOLM
LETHBRIDGE
MAGRATH
WARNER
LEGEND
BROWN
DARK BROWN
THIN BLACK
BLACK
DEGRADED BLACK
GREY WOODED
Unexplored
(Alberta Soil Survey)

the increases in yields resulting from fertilization will vary over a wide range. While an investment in fertilizers for stubble crops may pay off well in some years there is more risk involved than in fertilization of crops grown on fallow because the cost is higher and the response more erratic.

Experiments conducted in Alberta over the last 10 years have shown that about one-third of the grain crops tested on stubble gave profitable returns from the use of nitrogen feritlizers.

Since some remarkable yield increases have been obtained however, it is important that farmers study their cropping program carefully. If spring reserves of sub-soil moisture are good, if previous crops have shown symptoms of nitrogen deficiency, and if the market value of the crop is good, an investment in a nitrogenous fertilizer would likely pay dividends.

SOIL TESTING SERVICE

A chemical soil test is sometimes helpful in selecting the right fertilizer. The Alberta Department of Agriculture in co-operation with the Faculty of Agriculture, University of Alberta, operates a soil testing laboratory where farmers may have their soils analyzed at a cost of 50 cents per sample. For most meaningful results soil samples have to be collected very carefully and the analyst needs some basic information on the cropping history. Your District Agriculturist can give you detailed instructions on how to take your samples, how and where to mail them, and information that needs to be supplied. Analytical results are mailed out accompanied by a letter containing some practical suggestions from a member of the Fertilizer Committee. During rush seasons several weeks should be allowed for the processing of your soil samples.

Recommended Rates of Fertilizer

Brown Zone

Moisture is the major limiting factor in crop production in this zone and fertilizers are not generally recommended. In heavy textured soils, however, especially when moisture reserves are good, the use of 11-48-0 at 30 to 40 lb./Ac. drilled in with the seed is likely to prove profitable on grains grown on fallow. This would probably also apply to flax, rape and mustard. Tame grasses for hay or seed will also respond well to nitrogen when moisture conditions are good. For seed production, broadcast in early September 33.5-0-0 at 75 to 150 lb./Ac. or 21-0-0 at 120 to 240 lb./Ac.; for hay broadcast in fall or spring.

Crop and Fertilizer	Dark Brown and Thin Black Zone	Black and Degraded Black Zone*
Wheat, Oats, Barley		
On fallow: Use 11-48-0 drilled in	at 40 to 45 lb./Ac.	at 45 to 55 lb./Ac.
On stubble or after clover crop (see special note on page—, "Fertilizing Stubble Crops")		
(a) Light stubble or trash: 16-20-0 drilled in	at 75 lb./Ac.	at 80 to 90 lb./Ac.
or 24-20-0 or 23-23-0	at 50 lb./Ac.	at 60 lb./Ac.
(b) Heavy stubble or trash or following sod-breaking: Either 27-14-0 drilled in	at 100 lb./Ac.	at 120 lb./Ac.
or { 33.5-0-0** broadcast	at 50 to 75 lb./Ac.	at 60 to 90 lb./Ac.
plus 11-48-0 drilled in	at 40 lb./Ac.	at 50 lb./Ac.
Grasses		
(a) Grown for seed:	33.5-0-0 at 100 to 300 lb./Ac. or 21-0-0 at 150 to 450 lb./Ac. or 27-14-0 at 100 to 300 lb./Ac. broadcast as soon as possible after seed harvest.	
(b) Grown for forage:	Same as above in early fall or early spring.	
Legumes		
For forage or seed production: 11-48-0	at 75 to 150 lb./Ac.	at 100 to 175 lb./Ac.

Grass-Legume Hay Mixture		
(a) With less than 25% legume:		
27-14-0	at 80 to 160 lb./Ac.	at 100 to 200 lb./Ac.
or 16-20-0	at 100 to 200 lb./Ac.	at 125 to 250 lb./Ac.
or 24-20-0 or 23-23-0	at 65 to 135 lb./Ac.	at 85 to 165 lb./Ac.
	broadcast in early fall or early spring.	
(b) With over 25% legume:		
11-48-0	at 75 to 150 lb./Ac.	at 100 to 175 lb./Ac.
Flax, Rape, Mustard, and Rye		
(Note—Few official tests have been done on these crops. Rates are suggestions):		
On fallow: Try 11-48-0	at 30 to 40 lb./Ac.	at 35 to 45 lb./Ac.
On stubble or sod-breaking:	Try 33.5-0-0 broadcast at 100 lb./Ac. plus 11-48-0 at 30 to 40 lb./Ac. at time of seeding	Try 33.5-0-0 broadcast at 120 lb./Ac. plus 11-48-0 at 35 to 40 lb./Ac. at time of seeding

°Recommendations for the Degraded Black soils of the Ft. Vermilion area are discussed in a separate section on page 16.

°°The 33.5-0-0 (ammonium nitrate) could be replaced in the Dark Brown and Thin Black Zones by 80 to 120 lb./Ac. of 21-0-0 (ammonium sulphate) or 20 to 30 lb/Ac. of 82-0-0 (anhydrous ammonia) and in the Black and Degraded Black Zones by 95 to 145 lb./Ac. of 21-0-0 or 25 to 35 lb./Ac. of 82-0-0.

Grey Wooded Soil Zone

(A) AREA WEST AND NORTH OF MAIN BLACK SOIL ZONE

The key to high yields here is the combined use of proper fertilizers and crop rotations including grass-legume mixtures. Most of the soils in this zone are deficient in sulphur as well as nitrogen, phosphorus, and organic matter. In general, therefore 16-20-0 (with 14% sulphur) and 21-0-0 (with 24% sulphur) are likely to give the best responses, especially with legume crops, and are the main fertilizers recommended. Alternatively fertilizers supplying only or primarily sulphur may be applied to legume crops and a phosphate fertilizer such as 11-48-0 may be used on grain crops.

GRAINS

On fallow or light stubble—16-20-0 at 60-80 lb./Ac.

On heavy stubble—21-0-0 at 100 to 150 lb./Ac. broadcast plus 11-48-0 at 40 lb./Ac. drilled in.

FLAX OR FALL RYE

A few tests suggest that 16-20-0 at 40 to 60 lb./Ac. would be worth trying.

GRASSES

(a) Grown for seed—16-20-0 at 150 to 200 lb./Ac., or 21-0-0 at 150 to 300 lb./Ac.

(b) Grown for forage—16-20-0 or 21-0-0 at 100 to 200 lb./Ac.

GRASS LEGUME HAY MIXTURES

16-20-0 at 100 to 150 lb./Ac. to supply nitrogen, phosphorus and sulphur, **or** 21-0-0 at 75 to 150 lb./Ac. to supply nitrogen and sulphur, **or** sodium sulphate or calcium sulphate (gypsum) at 75 to 150 lb./Ac. to supply sulphur, **or** pure sulphur at 20 to 50 lb./Ac. In general, the higher the percentage of legume in the stand, the lower should be the proportion of nitrogen in the fertilizer applied and the higher the proportions of phosphorus and sulphur.

LEGUMES FOR SEED

Use 16-20-0 at 50 to 60 lb./Ac. with nurse crop. On established stands broadsast 16-20-0 at 50 to 60 lb./Ac. in fall or early spring, or else use sodium sulphate or gypsum at 40 to 60 lb./Ac., 21-0-0 at 30 to 50 lb./Ac. or sulphur at 10 lb./Ac.

(B) PEACE RIVER REGION

Very little evidence has been found of sulphur deficiencies in the Grey Wooded soils of this region. Good rotations and proper use of fertilizers are essential however.

WHEAT, OATS, BARLEY AND FLAX

On fallow—11-48-0 at 30 to 50 lb./Ac.

On stubble (see special note on page —: "Fertilizing Stubble Crops").

(a) Light stubble or trash—16-20-0 at 60 to 120 lb./Ac., or 24-20-0 at 40 to 80 lb./Ac., or 23-23-0 at 40 to 80 lb./Ac.

(b) Heavy stubble or trash or following grass-breaking:
Either 27-14-0 at 75 to 100 lb./Ac. drilled in **or** 33.5-0-0 broadcast at 75 to 100 lb./Ac. plus 11-48-0 at 25 to 40 lb./Ac. at time of seeding.

GRASSES FOR SEED OR FORAGE
33.5-0-0 at 75 to 150 lb./Ac., or 27-14-0 at 100 to 200 lb./Ac.

LEGUMES AND GRASS-LEGUME MIXTURES
Follow same recommendations as for Dark Brown and Thin Black Zones, page 14.

DEGRADED BLACK SOILS OF FORT VERMILION AREA

Tests conducted to date, although limited in number suggest the following:

WHEAT, OATS, BARLEY, AND FLAX
On fallow—11-48-0 at 40 lb./Ac., drilled in.
On light to medium stubble or trash—try 16-20-0 at 80 lb./Ac.
On heavy stubble or trash and following grass breaking—try 27-14-0 at 100 lb./Ac, drilled in, or 33.5-0-0 at 100 lb./Ac. broadcast plus 11-48-0 at 40 lb./Ac. at time of seeding.

GRASSES FOR SEED OR FORAGE
Use a high nitrogen fertilizer. See under Dark Brown and Thin Black Zones for recommended rates.

FERTILIZERS ON IRRIGATED SOILS

All irrigated soils will respond to barnyard manure and commercial fertilizers. These soils should be farmed intensively and a program of improving and maintaining fertility pays off in higher crop returns.

GRAINS
16-20-0 at 100 to 150 lb./Ac. or 24-20-0 or 23-23-0 at 65 to 100 lb./Ac. drilled in with seed. If there is a heavy trash or stubble additional nitrogen may be needed and 27-14-0 at 125 to 175 lbs./Ac. would be better. Alternatively broadcast 33.5-0-0 at 100 lb./Ac. and drill in 11-48-0 at 50 lb./Ac.

ALFALFA HAY
11-48-0 at 100 lb./Ac. top-dressed in early spring.

GRASS-LEGUME MIXTURES
Same as for alfalfa, followed by a top-dressing in June of 33.5-0-0 or 21-0-0 at 100 lb./Ac.

SUGAR BEETS
11-48-0 at 100 lb./Ac. planted with seed plus a pre-seeding treatment or side-dressing of 33.5-0-0 at 200 lb./Ac., 21-0-0 at 300 lb./Ac., or 82-0-0 at 80 lb./Ac.

CANNING CORN
11-48-0 at 80 lb./Ac. planted with seed or side-dressings of 16-20-0 at 100 to 150 lb./Ac., or 27-14-0 at 100 to 150 lb./Ac.

PEAS AND BEANS
11-48-0 at 50 lb./Ac. at seeding time in separate bands or broadcast prior to planting.

POTATOES
11-49-0 at 150 lb./Ac. in bands slightly below and to the side of the seed pieces.

FERTILIZING SPECIAL CROPS

POTATOES (non irrigated)
Tests so far suggest that the use of 11-48-0 should be placed in bands an inch or two at 100 to 200 lb./Ac. The fertilizer below and to the side of the seed pieces.

GARDENS AND LAWNS
Any of the fertilizers containing nitrogen and phosphorus can and should be used on gardens and lawns. For complete information write to Department of Extension, University of Alberta, Edmonton. Ask for Circular No. 30, "Soils and Fertilizers for Alberta Gardens and Lawns."

REFERENCES

University of Alberta, Edmonton
Colored Soil Zones Map.
Bul. 21 — Grey Wooded Soils and Their Management.
Cir. 30 — Soils and Fertilizers for Alberta Gardens and Lawns.
Bul. 44 — Cropping for Profit and Permanency.

Dept. of Agriculture, Edmonton
Pub. 5 — Fertilizers in Alberta
Pub. 70 — Fertilizer Recommendations for Alberta

Dept. of Agriculture, Ottawa
Pub. 985 — Soil Management Practices in the Upper Peace River Region.

Soil Management

Good soil tilth and fertility are of prime importance in erosion control. The objective should be not only to maintain soil fertility and tilth but to improve the soil by proper use of fertilizers, crop rotations and judicious use of tillage implements.

Soil Drifting

The threat of soil drifting is not limited to periods of below-normal precipitation, although continued drought intensifies the hazard. Soil drifting can occur in the chinook belt during the winter when warm westerly winds remove the snow. High velocity winds, sweeping across a finely pulverized soil surface, dislodge fine particles. These, in turn, dislodge and abrade other particles, and drifting becomes cumulative. Frost action breaks down clod structure and predisposes the soil to erosion.

Very fine particles, high in fertility, are transported considerable distances. Larger particles, low in fertility, are deposited along fence rows and ditches. Soil drifting seriously reduces the fertility of the soil.

Any practice or agency that will reduce surface wind velocity will reduce or prevent soil drifting.

Three factors that influence the extent of erosion are: surface cover, clod structure, and roughness of the surface. A cover of plant residues or growing crop prevents erosion by reducing surface wind velocity. Granules or clods too large to be moved by wind protect the finer particles from wind action. Cloddy structure is a useful protective measure. Frost action, the impact of raindrops, and other weathering agencies erode surface clods, and sandy and clay soils are particularly subject to weathering. A rough surface helps reduce surface wind velocity, and the deliberate smoothing of a field with harrows or other implements should be avoided.

CONTROL PRACTICES

Trash Cover Farming—Trash cover farming, properly carried out, provides a most effective long-range control practice for grain farms. It is defined as a system of managing cereal stubbles and other plant residues to protect the soil from erosion. Excellent protection is obtained if from 1,500 to 2,000 pounds of surface trash per acre are maintained on the surface of the seeded field. Spring wheat produces about 100 pounds of straw with each bushel of grain in the dark brown soil zone, slightly less in the brown soil zone, and somewhat more in the black and grey wooded soil zones.

Wise choice of tillage and seeding equipment is essential.

The wide-blade cultivator will conserve 70 to 75 per cent of the original surface trash after three of four operations.

Heavy-duty cultivators and duckfoot cultivators conserve 50 to 60 per cent of the trash after two operations. Excessive shovel pitch at a shallow depth, particularly in short, thin stubble, adversely affects trash conservation with these machines.

The one-way disc and the flexible-disc harrow conserve about 50 per cent of the existing trash with each operation at a depth of 3 to 3½ inches. Twenty-five per cent of a 10-inch stubble will be conserved by a oneway operated 5 to 6 inches deep. In contrast, 75 per cent will be conserved by disc implements if operated about 2 inches deep and at a narrow setting.

The rod weeder when used for secondary tillage is equal in trash conservation to the wide-blade cultivator. A disc implement at shallow depth followed by a rod weeder or wide-blade cultivator conserves trash almost as well as the blade cultivator.

The management and handling of trash cover occasionally present difficulties, but these can usually be overcome by foresight and planning

Spring wheat crops yielding less than about 15 bushels per acre require careful conservation of trash. Combine stubble should be left as high as possible. All tillage operations, including seed-bed preparation, should be conducted with subsurface cultivators. The rod weeder is useful for final seedbed conditioning. The crop should be seeded with a double-disc or hoe-type drill. Packers, if used, should be of the subsurface type. Thin stubbles, for a second-year crop, can be successfully sown with a combination of subsurface cultivator, rod weeder if necessary, and either of the above seeders. The one-way disc-seeder combination can be used, but trash protection may be inadequate.

Handling trash from spring wheat crops of 25 to 40 bushels per acre (2,000 to 4,000 pounds of straw) presents no serious problem. Fallowing should be conducted either with a subsurface cultivator or with a combination of disc implement and rod weeder or blade cultivator. Trash reduction should be limited

to that obtained by one 3- to 4-inch-depth operation with a disc implement either during fallowing or when preparing the seedbed. Most types of seeders will do adequate work under these conditions. Stubbling-in on the above field can be carried out successfully using the one-way disc-seeder unit, a disc drill on a one-wayed seedbed, or a hoe drill on a seedbed prepared by a wide variety of implements. Packing is essential for successful stubbling-in.

Stubbles in excess of about 4,000 pounds can be fallowed with little difficulty. Adequate trash reduction can be obtained from about two operations with a disc implement during fallowing and seedbed preparation. Straw, if not uniformly spread by the straw spreader or straw chopper, can be broken down and spread over the seedbed with an oscillating or a flexible harrow when the straw is dry and brittle. A wide-trash-clearance hoe drill and, if the seedbed is carefully prepared, the disc drill can be used. Extra precautions must be taken to stubble-in trash in excess of 4,000 pounds. Initial tillage with disc implements should be designed to chop up the straw. Secondary tillage should further reduce the trash cover. Trash harrows may be required to spread and break-up the trash. Wide-trash-clearance hoe drills are well adapted for seeding under these conditions, and the use of commercial nitrogen fertilizer as recommended in the fertilizer section of the Guide should be considered.

Burning stubble or windrows of straw leaves the soil exposed to wind action, and damage to the soil and to the young crop can occur. The benefits from burning (ease of operation and, only on occasion, a slight yield increase) seldom, if ever, outweigh the loss of fertility or the cost of reseeding a crop. Straw can be handled without burning.

Clod structure on fallows supplements trash cover as an erosion control aid. Timeliness of tillage with respect to soil moisture is a factor in maintaining some clod structure. Disc implements should not be pulled at a high speed in a soil that is readily pulverized. Chisel plows, and under certain conditions the duckfoot, heavy-duty cultivator and rod weeder, can be used to establish a cloddy condition. Seedbeds should not be coarse and open, although some clods are permissible between the rows. Subsurface packers and press wheel carriage drills are useful.

Strip cropping has proved valuable, particularly when combined with trash cover. Narrow field strips reduce the spread of drifting from focal points in a field. Strips from 8 to 16 rods wide are recommended on sandy and clay soils. On loam, silt loam, clay loam, and silty clay loam, strips 16 to 20 rods or slightly wider have been successfully used. Strips should be at right angles to the prevailing wind, or, if conditions are suitable, contour stripping may be practised.

Good shelterbelts decrease wind velocity for a distance to the leeward of up to 20 times the height of the belt and for a short distance to the windward side. Increased crop yields to the leeward of shelter belts may be attributed to increased moisture conservation. In park belt areas adequate shelter belt strips should be left to prevent serious wind erosion.

Shelterbelts are planted at right angles to the prevailing wind and at a distance of 20 to 40 rods apart. Contour planting of shelterbelts, combined with grassed strips and grassed water runways, is useful for both wind and water erosion. Keep tree belts at least 8 to 10 rods from a road allowance to avoid blocking roads in winter and follow regulations with respect to planting belts next to highways. For information on trees and planting procedure, see the section on tree planting.

Cover crops to protect soil and provide fall pasture are used in moister areas of the dark brown soil zone. Oats are seeded on fallow late in July at a rate of three-quarters to one bushel per acre. Overgrazing destroys protective value of the cover. On irrigated land a cover crop, seeded on sweet clover or canning pea land after the clover is plowed under or the peas are harvested, will protect the soil and provide fall pasture.

Sandy soils do not form weather-resistant clods and are very subject to drifting.

For grain production in the moister areas of the dark brown soil zone and in the black and grey wooded soil zones, complete trash cover farming can be used. A cover crop will protect the fallow during the fall and winter preceding the main crop. A grass and legume mixture or grass alone, either as a permanent crop or in rotation also is useful in these areas.

In dry regions seeding-down sandy areas to permanent pasture is strongly recommended. Continuous cropping to cereal grains requires the best use of moisture from snow trapped in the stubble and a careful weed control program. In drought years trash cover from weed growth and the use of deep listing may be required to prevent or control erosion.

SOIL DRIFTING ON IRRIGATED LAND

Many cropping systems on irrigated land do not lend themselves to trash cover farming. Pasturing-off crop residues such as beet tops and corn stovers pre-disposes soil to drifting because of the trampling by cattle and sheep.

Fall irrigating and subsequent fall plowing when soil moisture is conducive to clod formation is recommended. Fall-plowed land should not be disced and harrowed. Fields unsuited to mouldboard plowing should be shallow chiselled to roughen the surface. Cover crops should be used where practical.

Emergency control should be started at the first signs of drifting to protect the fertility of valuable irrigated soils.

Emergency Measures

1) Winter drifting can be controlled by shallow chiselling with a heavy-duty cultivator with every other shank removed. Light toolbar cultivators may be severely damaged if used in frozen soil. One-way discs with three out of four pans removed make excellent listers for frozen soil. The use of chisel blades on the shanks of a heavy-duty cultivator, or other methods of plowing light furrows every 6 to 10 feet, will check drifting on a winter wheat field and save the crop from destruction. Spreading manure or straw on small focal points will frequently check soil movement.

2) Drifting of non-frozen soil can be checked by any tillage operation that produces a rough cloddy condition. Chisel plows and other cultivators may be used. Plowing furrows around a field at frequent intervals helps. Under severe conditions, listing is required. Lister furrows, formed with a one-way lister or a cultivator with alternate shovels removed and the remainder steeply pitched, should be about 30 inches apart. If sufficient soil has been trapped to fill the furrows, the listing operation should be repeated.

Water Erosion

The problem of water erosion in Alberta demands consderation of principles governing erosion, survey of precipitation data and assessment of damage and of control methods.

The principles governing water erosion are three: rainfall characteristics, field characteristics, and soil properties.

We are concerned not only with total rainfall but also with intensity. A soil can hold only so much water and the water can be absorbed only up to a certain rate. When that rate is exceeded or if intensity exceeds infiltration, run-off and erosion occur. Rain drops pulverize exposed soils, liberating clay, silt and fine sand particles to be carried away in the run-off.

Steepness and direction of slope, and the nature and amount of protective cover, determine to a large degree the amount of erosion.

With respect to soil, structure is the dominant factor because it determines infiltration rate and erodability. Soil structure in turn depends on the relative amounts of sand, silt, and clay (soil texture), the quantity and nature of organic matter, the chemical nature of the soil, and the method of handling the soil.

Precipitation Studies

Average annual precipitation in Alberta's crop growing areas varies from 14 to 20 inches, 70 to 80 per cent of which falls during the six months, April to September. Total rainfall in the crop growing period is not as high as in some places and the erosion problem is therefore less acute.

Averages of rainfall for the crop growing regions of the province are less than 3 inches in May, less than 4 inches in June, less than 3½ inches in July, and less than 3 inches in August. Usually the storms are well distributed and rarely are our soils filled to capacity.

The few records available indicate that rainfall intensities in Alberta are also low compared with those in areas where water erosion is serious. The record 24-hour rainfall at Edmonton over a 10-year period is 4.17 inches and Thorsby reported the provincial record of 4.83 inches one day in July, 1937. Many of the south eastern Unted States have reported storms delivering over 10 inches in 24 hours. In storms of short duration too our Alberta cloud bursts are mild by comparison. Record storms have delivered less than 2 inches in one hour but elsewhere as much as 5 inches or more have fallen in this period.

Since neither total rainfall nor rainfall intensity in Alberta are severe enough to cause **conspicuous** damage, there is a tendency on the part of farmers to disregard water erosion completely. This is bound to result in excessive run-off, gullying, and erosion of precious top soil.

Soil Losses

The amount of soil lost by sheet erosion from the overall surfaces of our fields is small. However, where slopes are long and uniform and impervious layers in the soil prevent infiltration, severe sheet erosion has occurred. This has been observed in the Peace River area especially. In general the most serious problem in Alberta is the formation of gullies in more and more fields. These are a hindrance to cultivation, dangerous to operators, a weed trap, and represent large losses of soil and water. Closely related to prevention of water erosion is rainfall conservation. Control of run-off and erosion not only conserves rainfall and valuable top soil but also assists in preventing wind damage.

Control Measures for Alberta

1. Follow a good crop rotation to build up the organic matter and fibre content of the soil. Include grass and legume crops, especially in the moister regions of the province. Avoid summerfallowing in the moister regions of Alberta except for control of weeds like couch grass. Maintain a trash cover if possible when land is not in crop. Avoid overworking and pulverizing the soil. When possible use implements such as the one-way, cultivator, rod-weeder, and blade weeder, which leave the trash on top and do not pulverize the surface soil. Conserve all crop residues. Do not burn straw or stubble.

2. Seed down waterways that are likely to wash, using a hay mixture including grass.

3. Keep steep slopes in permanent grass or tree cover. Re-grass or re-forest steep slopes where necessary.

4. Practice strip cropping across slopes of cultivated fields that tend to wash severely. Contour cropping may occasionally be required. Plant cultivated row crops across rather than up and down slopes that tend to wash. Plow and cultivate across rather than up and down slopes. A ridged surface left in the fall across a cultivated slope will tend to check spring run-off.

5. Grow cover crops or winter crops, when practicable, on fields that are likely to be damaged by spring run-off. Spread straw or barnyard manure on slopes where washing is likely to occur, and dam runways with straw, brush, stones, or other material.

Moisture Conservation

Moisture is the main factor limiting crop production in the south and east central areas (Brown and Dark Brown soils). The average annual precipitation is about 13 inches with frequent dry winds reducing the effect of the rainfall. To the north and west (Thin Black Soils) the average annual precipitation varies from 14 to 16 inches. Due to lower average temperature and less wind, each inch of rainfall is more effective here than in the brown and dark brown soil zones.

Soils differ considerably in their capacity to store moisture. Clay soils can store more than twice as much as sandy soils. This, in part, explains the greater drought resistance of clay soils.

One purpose of summerfallowing is to store moisture for the following crop. The soil surface during fallow must allow for easy entry of water by maintaining trash cover and ridging the field parallel to slopes. Fallow land should be kept weed free to prevent loss of the stored moisture. Every inch of moisture conserved means extra bushels in next year's crop.

Good fallow should:

(a) Prevent weed growth by timely and proper cultivation.

(b) Provide for the control of erosion as outlined on pages 17-19.

(c) Assist in the control of insect pests especially wireworms and cutworms. (See page 89.)

The depth of moist soil in a stubble field may be determined with an auger. The change from moist to dry soil is easily observed. Moist soil will "ball" when squeezed in the hand. Dry soil is lighter in color and is harder to bring up with the auger. In the Brown and Dark Brown soil zones less than 27 inches of moist soil indicates a poor reserve, insufficient for a satisfactory crop in the average season.

Summerfallow to increase the storage of reserve moisture is needed within the brown and dark brown soil zones and the thin black soil zone. On the other hand, summerfallow for moisture conservation should not be considered an essential practise on the black or grey wooded soils. The yearly distribution of precipitation is more reliable within these latter areas where fallowing should be practised only for weed control or when breaking grass sod in a crop rotation.

Special Problems

Saline and Alkali Soils—See section under Irrigation.

Solonetzic Soils—This term refers to soils known as burn-out or blow-out, sometimes called hardpan or gumbo. They are all characterized by a hard, impervious sub-soil layer, which prevents entry of plant roots and soil moisture. This hard layer is especially troublesome and difficult to work.

The most extensive area of solonetzic soil in Alberta occurs in a band extending from Bruderheim on the north to near Suffield on the south (nearly 250 miles) and averages 35 miles wide, attaining maximum width of 60 miles in the vicinities of Brooks and Coronation. Other significant areas of solonetzic soils are found in the Peace River region, Leduc, Clyde, Cardston, Coutts, Manyberries and Chancellor.

In the dry regions these soils cannot be successfully cropped, although irrigation and cropping studies are continuing.

In the moister regions of the province, solonetzic soils are being farmed with some success. Timing of cultivation and use of deep rooted legume crops have improved many such soils. All available organic matter in

the form of straw, stubble and manure should be worked into the soil. This is especially important during the fallow year when additional moisture will also assist in the breakdown of this organic matter or fibre. Gypsum and other soil amendments are being tested and may prove beneficial.

Land should not be tilled when the soil is too wet or too dry. If too wet, it has a tendency to bake upon drying and will be difficult to handle. If too dry, many lumps difficult to break down will be brought to the surface.

It is advisable to fallow solonetzic soils regularly for moisture conservation and to maintain good tilth. The summerfallow should be worked early in May to a depth of 4 to 5 inches. For the first operation a one-way is a suitable implement, unless stubble is light and the soil dry, in which case a cultivator or blade implement should be used. Through the remainder of the season cultivation may be done with a blade implement, duck-foot cultivator or rod weeder. A depth of 3 to 4 inches is suitable for these later operations. Early working of the summerfallow is most important so that these soils may be kept moist and friable throughout the season.

Solonzetic soils tend to improve under cultivation, due to increase in organic matter and improvement in tilth. Recommended crop rotation, power equipment, and careful management are all essential to best use of such soils.

Peats—In Alberta, peat occurs mainly in the grey wooded soil zone, but there are numerous minor areas in the Degraded Black and Black soil zones. Many small areas have already been brought under cultivation. Peat covers an estimated 25 million acres in Alberta, but few of the great muskegs of northeastern Alberta will likely be reclaimed.

The peats are usually underlaid by clay or other soil material fine enough to hold the moisture in basins or flats, which permitted and encouraged the growth of sphagnum moss and other moisture loving plants. Most of the Alberta peats studied have been classified abroad as high moor or moss peats, but they are commonly called muskegs in this country. Alberta peats, classified as lowmoor, sedge or grass peats, are usually shallow, rich in lime, dark in color, and relatively fertile. Chemically, Alberta peats differ widely.

In nitrogen content they range from less than 1.0% to more than 2.5%. Although relatively high in nitrogen they frequently respond to nitrogen fertilization in Alberta.

Their phosphorous content varies less and is not very high compared with mineral soils. Peats reclaimed for crop production are frequently deficient in available phosphorous. The potassium content of some Alberta peats is very low, suggesting a need for potash fertilizers.

Alberta peats vary from about pH 4 on the acid side, to about pH 8.5 on the alkaline side. pH 7 is neutral. The calcium content varies from less than 1.0% to nearly 5.0%. According to some investigations peats in need of lime narrow down to those with pH values of 3.5 to 4.5. Those with 2.0% or more of calcium are not likely to require lime for crop production.

Experimental work with peats has not been carried on long enough in Alberta to make certain of the best methods of bringing them under cultivation. The first step naturally is to drain the land. However, it should be realized that the draining of peat bogs, like the clearing of forests, dries up reserve moisture in dry seasons and increases water erosion in wet seasons. In their undrained state peat bogs form natural reservoirs and feed the streams that would otherwise dry up in dry seasons. Peat bogs should not be drained unless the land is to be reclaimed for pasture or other crop production.

Muskeg, after it has been drained is sometimes burned to increase its productivity. Burning is likely to leave the field in a very irregular condition, or in the case of shallow peats, too little organic matter will be left for a good seed bed. Don't set fire to the peat after a prolonged dry spell. Many peat areas in Alberta have been seriously injured by excessive burning.

Freshly plowed peat land should be disced and, preferably packed to make a firm seed bed. Discing without plowing is often sufficient preparation for subsequent crops. Greenfeed such as green oats may be grown as the first crop, and later it should be possible to ripen early barley or other grain crops on some of this land. Frost damage to grain, potatoes, and other susceptible crops, is more frequent on peat soils than on adjacent mineral soils, because less heat is radiated from peats than from mineral soils on cold nights, and because peats commonly occupy the lower areas. Early ripening barley is probably the safest crop for grain production. It is likely that most of our reclaimed peat land will eventually be seeded down to grass and clover, as this is the easiest way of handling such land. Brome grass and reed canary grass have produced good yields of hay on some Alberta peats. In a mixture of brome, timothy, alsike clover and alfalfa the legumes were not well main-

tained. Legumes generally require good drainage and soil aeration, and peat soils are apt to become water-logged at times, not only because of their low-lying position, but also because of their high water-absorption capacity. Grasses generally can withstand temporary water-logging much better than legumes and often thrive on an abundant supply of moisture. Satisfactory yields of bromegrass seed have sometimes been produced on Alberta peats.

Peats differ greatly in their ability to produce crops, and for this reason their fertilizer requirements cannot often be predicted without actual field trials. They vary greatly in reaction, and many moss peats are very acid and should respond to treatment with lime. When marl deposits rich in lime are conveniently located, this material might be applied to a part of the muskeg at the rate of, say, one ton per acre, and its effect could then be observed. Where reaction is satisfactory and yields are unsatisfactory the application of barnyard manure or commercial fertilizer is apt to prove beneficial. Profitable increases in early barley and hay have been obtained in many cases from the application of a complete fertilizer containing nitrogen, phosphorous and potassium, and sometimes from a fertilizer containing nitrogen and phosphorous, whereas in other cases no appreciable increases have been obtained.

References:

Department of Agriculture, Ottawa
Pub. 896—Soil Drifting—Causes and Control.
Pub. 895—Soil Management Practices in the Upper Peace River.
University of Alberta, Edmonton
Bull. 21—Grey Wooded Soils and Their Management.
Soil Survey, Grande Prairie and Sturgeon Lake Sheets.
Bul. 56—Water Erosion in Alberta.
Line Elevators Farm Service, Grain Exchange Bldg., Winnipeg
Circ. 19—Protect Prairie Soils.

Irrigation

EXTENT AND LOCATION

Irrigation in Alberta developed its first major project in 1901 when the Alberta Railway and Irrigation Company completed the main works to divert water from the St. Mary River at Kimball, Alberta, which provided irrigation for about 600 acres of land near Lethbridge and 3,000 acres in the Magrath District.

The Governments of Alberta and Canada and the Canadian Pacific Railway have developed the major irrigation projects in Alberta. Small projects have been developed by individuals and through the assistance of the Prairie Farm Rehabilitation Administration. At the present time, irrigation works are owned and operated by either the Governments or the farmers. The following table and accompanying map outline the location and extent of irrigation projects in the Province of Alberta:

Source of Supply	Project	Closest Centre	Constructed by	Year Dev.	Approx. Acres Under Irrig.	Total
Bow River	Bow River Proj. (Vaux. Block)	Vauxhall	Can. Lands & Irrig.	1920	60,000	
	Bow River Proj. (Hays Block))	Hays	P.F.R.A.	1955	27,000	
	Bow River Dev. (West. Block)	Enchant	Prov. Gov.	1958	35,000	
	Western Irrig. District	Strathmore	C.P.R.	1911	41,500	
	Eastern Irrig. District	Brooks	C.P.R.	1914	200,000	363,500
Belly River	United Irrig. District	Glenwood	Farmers	1924	34,000	
	Mountain View Irrig. Dist.	Mountain View	Farmers	1932	3,600	
	Leavitt Irrig. District	Cardston	Farmers	1943	4,600	
	Aetna Irrig. District	Cardston	Farmers	1943	8,300	50,500
St. Mary River	S.M.R.D.		A.R. & I.	1901	82,000	
	Leth. Dist.	Lethbridge	A.R. & I.	1926	7,000	
	Magrath Dist.	Magrath	A.R. & I.	1925	15,200	
	Raymond Dist.	Raymond	Farmers &	1920		
	Taber Irrig. District	Taber	Prov. Gov.	1950	30,600	
	S.M.R.D.-East Sec. Chin to Medicine Hat	B. Island	Prov. Gov. & P.F.R.A.	1955	122,000	256,800
Old Man River	L.N.I.D.	P. Butte	Farmers	1923	96,100	
	S. Macleod Dist.	Macleod	Prov. Gov.	1948	3,000	99,100
	Ross Creek Irrig. Dist.	Med. Hat	P.F.R.A.	1949	2,100	
	Berry Creek Irrig Dist.	Wardlow	P.F.R.A.	1938	3,000	5,100

In addition to the above, there are about 650 private licensed irrigation schemes with a total area of approximately..... 70,000

Total number of irrigated acres in Alta.....845,000

Water Legislation

The basic principles of the water legislation in Western Canada are:

WATER SUPPLY

1. The ownership of all surface waters is vested in the Crown, and these waters or the right to their use can not become private property.
2. The use of water is regulated by licenses from the Crown, which are subject to cancellation for non-use or misuse.

Water Supply

The supply of water for irrigation use in Alberta is entirely adequate for all the projects now operating or presently under construction. Alberta is also very fortunate that the topography is particularly adapted to gravity diversion.

The greatest demand for irrigation water coincides quite closely with the period of peak runoff from the melting snow of the Rockies. Water requirements for autumn irrigation are taken from either river or off-river storage.

Legal Duty of Water

The legal duty of water for the irrigation season (May 1 to September 30) is 18", but some of the irrigation districts have diverted much more than this. Some of the earliest canals were designed to supply 1 c.f.s. for the irrigation season for every 150 acres. Such a flow would provide almost exactly (excluding losses) a total of 24" depth of water for an area of 150 acres providing the water users applied a continuous flow for 24 hours a day during the entire irrigation season. This design naturally restricted the rate of flow required to sustain uniform crop growth in a farm unit as all the area needs water in a reasonably short period to prevent deterioration of crops. The generally accepted minimum use is at the rate of 2.5 c.f.s. or 5 acre-feet per day. This volume applied to land in depths of 4" to 6" will irrigate 10 to 15 acres per day, thereby enabling 160 acres of land to be irrigated in 12 to 16 days. This rate of required flow is about twice that provided for in the original regulations.

On many of the earlier projects the structures were also inadequate. Experience has shown that while sound construction is expensive it is the best from a long range view.

The use of water for irrigation is classified as consumptive use and has preference over the use of water for water power or recreational use but is inferior in preference to the use of water for domestic, municipal, or industrial use.

Source of Water

All of our major existing projects derive their water supply from the South Saskatchewan River or its tributaries. The more important tributaries are the Old Man, Waterton, Belly, St. Mary, Highwood, and Bow.

The water supply for the S.M.R.D. is also affected by the use of water by the U.S.A., who divert water from the St. Mary River to the Milk River on the south side of the 49th parallel. This water flows down the Milk River channel and is subsequently re-diverted in the vicinity of Havre, Montana. The apportionment of the water of the Milk and St. Mary Rivers is governed by treaty. No agreement has been reached with the U.S.A. on the apportionment of water from the Waterton and Belly Rivers, which rise in Montana and flow through the prairies en route to Hudson's Bay.

Because irrigation represents consumptive use, the downstream provinces on the Saskatchewan basin are concerned about proposed extensions of irrigation developments in Alberta. This concern has moderated in recent years because of the construction of oil and gas pipelines bringing hydrocarbon fuels to those areas. In addition there has been a lessening of emphasis on the use of the Saskatchewan River delta at Les Pas for fur production and an increasing emphasis on the use of this fertile land for agriculture by diking and drainage.

There is, however, a definite limit to the acreage that can be put "under the ditch," and in the years to come there will be close scrutiny of the amount of water used in this province. The number of water measurement stations is being steadily increased not only on sources of supply but on actual diversions to the various projects, and in the case of irrigation works the return flow to the rivers is also measured.

Prairie Provinces Water Board

The Saskatchewan River flows through the three Prairie Provinces, and in order fairly to apportion the waters of the river a board has been established (1950) known as the Prairie Provinces Water Board. Each province has one representative on the Board, and the Dominion has two representatives. Although the Board is an advisory organization, it has the power to make allocations of water after each province has approved the allocations by appropriate Orders-in-Council. Alberta has been allocated 2,237,234 acre-feet of water to irrigate 1,256,453 acres.

LAND PREPARATION

The economical application of surface irrigation requires some land levelling and the development of an effective farm distribution system. This is obtained through technical services that provide surveys, designs, and

supervision of earth moving and construction. The benefits are: (1) a uniform application of water in even and equal amounts to the soil providing for earlier seeding; (2) uniform and higher yield; (3) water continuously under control, which reduces waste of water and land; (4) controls erosion; (5) assists in the prevention of salinity, alkali, and waterlogging; (6) the labour requirement is reduced; and (7) irrigation efficiency is definitely increased.

Land Levelling

Land levelling should be arranged well in advance of operations. The design is very important and should be prepared by competent personnel. Earth moving is most efficient on summer-fallow, but stubble land is quite suitable for scraper carry-all operations. Earth moving should be followed with deep chisel plowing, land planing and floating, check surveys of the levelling job, and the preparation of an efficient method of irrigation. Permanent crops should not be planted the first year following heavy earth moving as trimming is often required after irrigating. Some fill areas may settle and some cut areas may swell.

Structures

Structures for control in checking, diverting, or dropping of water can be built of wood, cement, or other material and strategically located in ditches at reasonable costs that will assure many savings in labour, water, and the waste of land.

Syphon Tubes

Syphon tubes and other equipment provide efficient control of water applied to the land.

Water Application

Water application should be made on each irrigation run by starting with a heavy flow, then, after about three-quarters of the run is wetted (which should be one-quarter of the total time for irrigating the run), the flow is reduced to an amount that will disappear into the soil through the full length of the run, thus reducing run-off to a minimum. Several syphon tubes, for example, can be used to begin with on each run then reduce to only one or two and at the same time start a new run.

METHODS OF IRRIGATION

The method of irrigation depends upon the crop to be grown, the type of soil, the slope of land, and the amount of water available.

Water Measurement

Water measurement is easily made with the provision of one or two well-installed water measurement structures in the farm ditches. It is important to know how much water is being applied on each irrigation run during any period of time. One cubic foot per second (c.f.s.) is equivalent to 397 gallons per minute (450 U.S. gallons) or one inch of water on one acre per hour.

Free Flooding From Contour Ditches

Free flooding from contour ditches is used on rough land with variable slopes where better methods cannot be used. The spacing of ditches and the handling of the water by the irrigator are very important for satisfaction with this method. Contour ditches drop at the rate of 1 to 3 inches per 100 feet of length and are spaced according to the following chart:

Soil Type	0.2% to 2% Slope		2% to 4% Slope		Over 4% Slope	
	Uniform	Irregular	Uniform	Irregular	Uniform	Irregular
	ft.	ft.	ft.	ft.	ft.	ft.
Sand	100	75	85	50	75	50
Loam	200	100	150	75	100	75
Clay	300	150	200	125	150	100

Run-Off Flooding Behind Dykes

Dykes built across flat draws collect run-off water which floods areas behind the dykes. Excess water is released to flood areas farther down the draws. Spring run-off is the main source of supply. This method is used particularly on ranches in providing hay meadows.

Border Ditches

Border ditches running parallel down slope are used on gentle, uniform slopes. The careful spacing of ditches and the length of run of water that is allowed by the irrigator determine the effectiveness of this method.

Soil Type	Length of Run	Ditch Spacing on Uniform Slopes	Ditch Spacing on Slightly Irregular Slopes	Ditch Spacing on Irregular Slopes
	ft.	ft.	ft.	ft.
Sand	200	100	75	50
Loam	300-400	150	100	50- 75
Clay	400-500	200-250	100-200	50-100

Furrow Irrigation

Furrow irrigation is used for row crops on land levelled to a uniform grade in the down-field direction. The amount and regulation of water in each furrow and the length of run are quite important.

Soil Type	Ditch Spacing—(Length of Run) 0.2% to 2% Slope ft.	2% to 5% Slope ft.	5% to8% Slope ft.	Size of Stream c.f.s. per furrow
Sand	250- 400	200-300	150-200	0.04-0.12
Loam	400- 880	300-660	200-300	0.02-0.09
Clay	880-1,320	400-880	250-400	0.03-0.013

Corrugations

Corrugations are small furrows used on broadcast- or close-seeded crops on soils that are fairly heavy or tend to crust. The land may be moderately to fairly level. This method is particularly useful for irrigated pasture crops on steep or irregular slopes or if only a small stream of water is available. The same ditch spacing or length of run is used for corrugation as is used for furrow irrigation.

Border Dykes

The border dyke method of irrigation is most efficient and requires the least amount of irrigating labour, yet irrigates the land at the fastest rate. It is highly recommended for all close-seeded crops, especially hay and pasture. It can be used on land that has been well levelled. Only one head ditch for each field is required for irrigating by this method. The dykes are 3 to 6 inches high and 2.5 feet wide, being located from 20 to 50 feet apart running parallel down the slope. The space between each pair of dykes is called a border, which provides the irrigation run.

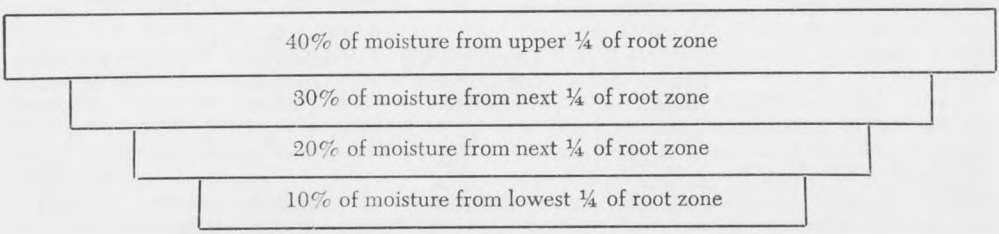
Irrigating Stream Size	Soil Type: Sand — Border Width	Sand — length of Run	Loam — Border Width	Loam — Length of Run	Clay — Border Width	Clay — Length of Run
c.fs.	ft.	ft.	ft.	ft.	ft.	ft.
1	20	200-300	20	330- 550	20	550- 770
1-2	25	330-440	30	550- 770	30	660- 880
2-4	30	440-550	40	550- 770	40	660-1,000
4-6	40	550-660	50	660- 880	50	880-1,320
6-8	60	660-770	60	880-1,320	60	1,320-1,500

Sprinker Method

The choice of a sprinkler system for irrigation is mainly an economic one. High-value-per acre crops are necessary to warrant the added expenses of operating a pumping unit, pipe and sprinkler, for this method. Sprinkler systems can be adapted for wide variations in soil and topography. It is a useful method on land too rough and soil too shallow to permit a minimum of levelling, on soil so porous that water cannot be applied by surface methods without serious loss, where the water supply is so small that surface methods are impractical, on steep slopes with highly erodible or impermeable soils, or where a crop requires very careful control of the amount of water applied. Since the use of sprinklers involves high costs, it should not be adopted where equally satisfactory results can be secured by surface methods.

SOIL MOISTURE RELATIONS

Root Zone: The root zone or area of soil that contains the plant roots is about 2 feet for shallow-rooted crops, 4 feet for most normal crop roots and as much as 6 feet for the roots of alfalfa. The following table shows the relative use of moisture by plants from varying depths of soil—



Plant Use of Moisture: Plant use of moisture for most crops is about 0.15 or 0.17 of an inch of water per day during the normal growing season. However, during the peak growth period and hottest days, crops will use 0.25 of an inch of water per day. One inch of water will be used in from four to seven days.

Readily Available Moisture: This is the moisture in the soil that is available for plants to use. It is about one inch for sand soils, 2 inches for loam soils, and 2½ inches for clay soils per foot of root zone depth. For example, a 4-foot root zone of loam soil can be expected to hold approximately 8 inches of readily available moisture. Following is a table showing the water-holding capacities of different textures of soil—

Soil Texture	Total Available Soil Moisture (Inches of water held per foot of soil depth)
Coarse sand	0.50-0.75
Sandy loam	1.00-1.50
Silt loam	1.50-2.00
Clay or silty clay	1.75-2.50

Time to Irrigate: Never let the soil dry out to the point where the plants suffer from lack of water. By the time plants show signs of injury they have needed water for about a week, so the time to irrigate is best determined by the amount of moisture in the soil. Fields should be irrigated when the upper foot of soil contains about one-half of its available moisture. With a little experience the irrigator can tell the amount of water needed by feeling the soil. The following can be used as a guide for determining the need for irrigation for any except very sandy soils: Dig down about 6 inches to a foot, take a handful of soil and form a ball with firm hand pressure. The ball of soil is then tossed a foot into the air and allowed to drop on the palm of the hand. If the ball does not crumble within five tosses more than half of the available moisture is in the soil, and irrigation is not needed. If the ball crumbles during the tossing, between one-quarter and one-half of the available water is left in the soil and irrigation should be started. If a ball cannot be formed, the soil has been allowed to become too dry and irrigation should be started immediately.

Fall irrigation of forage crops is recommended to lessen the danger of winter-killing. Fall irrigation of fields to be seeded the following spring ensures an adequate supply of moisture for germination. Fall irrigation means that the need for irrigation in the spring is usually delayed until after seeding operations are completed.

Irrigating Crops: See references. The amount of moisture in the soil determines the time to irrigate, and frequent soil sampling is the way to keep up with the water requirements of the crop. However, certain general recommendations can be made for specific crops, bearing in mind that weather conditions influence the need for irrigation. The following recommendations assume that a **good irrigation has been given in the fall** so that the soil has gone through the winter well supplied with moisture. All irrigations should fill the root zone to capacity. ALFALFA and Alfalfa Mixtures—Irrigate when the alfalfa is 10 to 12 inches high and again immediately after the first cutting has been removed. Irrigating after the second cutting constitutes the recommended fall irrigation. PASTURES—Pastures require frequent irrigation. Rotational grazing should be practiced, and the time of irrigation will depend on the length of time the stock are left on each field. Whenever the animals are moved, that portion of the pasture should be irrigated immediately. Pastures should be irrigated every two to three weeks. SUGAR BEETS—Sugar beets require frequent light irrigations started soon after thinning, applying enough water each time to connect up with the moist subsoil. Three or four irrigations are usually required. GRAIN—One irrigation at the shot-blade stage is usually sufficient. POTATOES—Potatoes need frequent light irrigations about every three weeks. If the soil is allowed to dry out between irrigations, reduced yields and lowered quality will result. No water should be applied for about a month before harvest. CORN—Corn is sensitive to too much water. Two irrigations, the first when the corn is about 2 feet high and the second at tasselling, are usually sufficient. CANNING PEAS—Canning peas should receive a good irrigation when about 6 to 8 inches high and a lighter application shortly before harvest.

Self Check on Irrigation Efficiency: An examination 48 hours after an irrigation of samples from each foot of soil to a depth of 5 or 6 feet will indicate whether or not enough water or too much water was applied. If the moisture in the soil is evenly distributed to the depth **only** of the root zone, then the irrigation is very efficient. If dry areas occur in the root zone, then the application was insufficient. If the soil is excessively wet below the root zone, then too much water was applied. Numerous checks with a soil auger should be made in each field. Corrections in irrigations, according to the findings of this checking system, can then be made at the next irrigation.

IRRIGATED FARM MANAGEMENT

Irrigation farming involves a number of

special management problems peculiar to this type of agriculture. Some of these are:

1. Higher capital investment per acre and higher per acre operating costs, when compared with dry land farming in the same area. Good irrigated farm land sells for a higher price than dry land in the same district. More machinery is required when compared with the same acreage of dry land. Additional labour is required to more intensively cultivate, irrigate and harvest crops on irrigated farms and to handle the necessary complement of livestock.
2. A more complicated balance exists between soil, fertility, water and plants when optimum quantities of water are applied to the soil. Special attention must be given to the management of the soil, including the use of soil-building crops, the use of manure and mineral fertilizers. It is also important to apply the right quantity of water to each kind of crop to obtain maximum yields. Good drainage of the soil becomes an important management problem. Lack of drainage can cause reduced yields, deterioration of land, and high costs to remedy the damage.
3. The necessity for higher gross and net returns per acre for smaller acreages farmed makes necessary the production of specialized crops where aptitude of the farmer, climate, soil and markets are suitable. This is usually coupled with the growing of legumes and forage crops to maintain fertility, the growing of feed grains, and the feeding of livestock including dairy cattle to consume these crops or their by-products. Where specialized crops cannot be marketed, the production of legumes, forage crops and cereal grains can most profitably be combined with one or more livestock enterprises. This is the most satisfactory way to ensure a readily available market for these crops. Intensively managed cultivated pastures are playing an increasingly important role in successful irrigation farming.

SOIL SALINITY AND DRAINAGE

Occurrence of Saline and Alkali Soils

When neither surface nor ground water drains away satisfactorily, concentration of the soluble salts near the soil surface results because of water evaporation. There are two distinct types of soil formed as a result of this salt accumulation—saline soils and alkali soils. **Saline** soils are those that have accumulated sufficient soluble salts, principally calcium and magnesium salts, to have an adverse effect on crop production. **Alkali** soils have a predominance of soluble sodium salts. The "blowout" or solonetz soils, which are examples of one type of alkali soils, are characterized by an uneven or pitted surface and an impermeable layer high in sodium (see section on Solonetz Soils, page 20). Most solonetz soils present problems under irrigation, and the costly reclamation measures necessary would likely make irrigation of such soils impractical. Although salt-affected soils occur widely in nature, the most serious situation in agriculture is encountered where previously productive soils are salinized as a result of irrigation.

Effect of Salts on Plants

The effects of the presence of excessive amounts of soluble salts on crop production are noted in poor stands, uneven growth, poor yields, and bare spots. Plant growth in these areas is retarded or prevented by the reduction of water uptake, or by some direct chemical or toxic effect. In addition, an alkali soil usually is in such poor physical condition that soil structure, permeability, and aeration are not favourable for growth. These effects are particularly critical when the plant is germinating, and therefore it is difficult to establish a stand under such circumstances. Salt concentrations in the soil can be measured, and from these measurements it is possible to predict or account for salinity effects on plant growth in the field. Then changes in crops planted or in cultural operations can be made if necessary.

Source of Salt Accumulation

Salts are present in the virgin soil, varying in concentration, in chemical composition, and in depth of occurrence with the soil type and with the rainfall pattern of the area. Water redistributes the salts in ways varying with the soil type, topography, and other factors. Some salt is invariably present in irrigation water, and so salts are added to the soil. The major irrigation districts in Alberta are fortunate in having a source of good quality irrigation water, low in salt content, diverted from the mountain streams. Water from wells, minor streams and ponds may have a much higher salt content and should be tested for quality for irrigation in the laboratory before use.

Soil Salinity Changes With Irrigation

Surveys have shown that under favourable conditions most of the salts originally present in many soils developed for irrigation to date in southern Alberta have been moved by the applied irrigation water to depths below the soil root zones. Salinity and water-logging prob-

lems have arisen mainly in certain areas where there are unfavourable conditions of inadequate drainage of surface waters, and high ground-water levels caused by over-irrigation and by seepage from canals, laterals, and head ditches. Evaporation of ground water is then increased with a corresponding increase in surface-soil salinity as the salts accumulate.

Emphasis on Measures to Prevent Soil Salinization

Most irrigated soils in Alberta have relatively tight subsoils which greatly restrict the ready movement of excess ground water. As a result, the removal of excess ground water through the soil by natural drainage is slow, and the removal by artificial subsurface drainage is difficult and expensive. The quantity to be removed by either means should be the least amount practical.

Salinity problems and drainage requirements in irrigation can be minimized by:

1. A careful selection of the lands to be irrigated, especially from the standpoint of soils and topography.
2. The provision of drains for excess surface water.
3. Lining canals, laterals, and head ditches where necessary to minimize seepage losses.
4. A knowledge of crop water requirements and the amount of water that can be stored in the soil and made available to plants, and the application of that knowledge in good irrigation practices to waste as little water as possible through the soil.
5. Suitable irrigation layouts and land preparation including land levelling.

Improving Salty Lands

Soil sampling, observations of ground-water levels and other field conditions, and laboratory analyses are necessary to diagnose the problems that arise in salt-affected areas and to determine remedial measures. To improve salty lands, an excess of water must be applied to wash the salts down and out of the soil root zone. There is no chemical treatment that will neutralize the salts, although, on alakali soils, some amendments such as gypsum may be helpful in addition to the washing. Usually, it will be necessary to supplement the natural soil drainage with covered tile or open drains to remove the excess subsurface water and salt and transport them out of the area. Both types of drain have been shown to be effective, with the effectiveness increasing with the depth and permeability of the soil. Many irrigated soils in Alberta have limitations with respect to both depth and permeability. For this reason, and also because of the cost, comparatively few installations of open or tile drains have been made in Alberta for subsurface drainage, and only limited data are available on their performance. Experimental work on the depth and spacing of drains is being undertaken, and observations are being made on field installations.

Farming Salty Lands

Where it is not considered feasible to lower materially the soil salinity levels, any of the following practices may be helpful in keeping lands in production:

1. The ploughing-down of farm manure, green manure, or crop residues.
2. Planting so as to avoid salt build-up around the seed. The soil can be ridged and the seed planted near the base. The salt migrates to the top of the ridge leaving a zone of lower salt concentration, which makes conditions for germination more favourable near the base.
3. More frequent light irrigations to keep plants supplied with readily available moisture.
4. The selection of crops most tolerant to the salt condition during germination and growth.

Below are some of the common field crops grouped according to their tolerance to salts. These groupings have largely been made on the basis of tests in other countries. They are considered, however, to be generally valid for local conditions. Differences in the salt tolerance of plant species will be encountered.

High Tolerance

Tall wheat grass	Sugar beets
Slender wheat grass	Garden beets
Rape	Asparagus
Barley	Spinach
Bird's-foot trefoil	

Moderate Tolerance

Crested wheat grass		Reed canary grass
Orchard grass		Wheat, rye, oats
Sweet clover	Flax	Potatoes
Alfalfa	Sunflower	Peas
Brome grass	Sweet corn	Tomatoes

Low Tolerance

White Dutch clover	Ladino clover	Field beans
Alsike clover	Red top	Strawberries
Red clover	Timothy	Green beans

Because of the complexity of salinity and drainage problems, the costs involved, and the need for a measurement program, farmers are urged to seek technical assistance. Inquiries should be directed to the irrigation district concerned or to the Provincial or Federal Departments of Agriculture.

References:

Department of Agriculture, Ottawa
Pub. 883—Irrigation Farming in Southern Alberta.
Pub. 509—Use of Irrigation Water on Farm Crops.

Cultural Practices & Crop Sequence

CROP SEQUENCE

BASIC RECOMMENDATIONS

Sow wheat on summerfallow or as a second crop on weed free land only. On stubble, coarse grains are preferable since they can better compete with the weeds.

Rotate crops. The same crop, year after year, encourages disease and insect pests.

Include forage in the rotation (except possibly in the drier areas of the Brown soil zone). Legumes add Nitrogen to the soil and improve tilth. Grasses add fibre and reduce erosion.

THE BROWN SOIL ZONE

Low annual precipitation and high seasonal evaporation characterize much of the brown soil zone. Farming here must make best possible use of the available soil moisture, and only the better soil types should be considered arable. Most of the arable soils lie in the western half of the zone where rainfall is between 13 and 14 inches annually. Even on the good soils the farm unit should be larger than in most other parts of the Province and handled as efficiently as possible.

Choice of dry land crops is limited. The major cultivated crop is spring wheat, and most farmers have adopted a wheat-fallow rotation. Some barley, flax or mustard seed may be grown in place of wheat but ensure that enough stubble remains to protect the soil from drifing during the fallow year. (See section on Wind Erosion.) Flax is a poor weed competitor and should be seeded only on clean land. Mustard should be grown only under contract with a reputable seed firm. On sandy soils and light loam soils fall rye is a suitable grain crop. Near the western boundaries of the brown soil zone when stubble land has a depth of over 27 inches of moist soil at seeding time, some stubble may be re-cropped rather than fallowed.

Although little grass has been grown to date on cultivated land in this zone, considerable permanency, through maintenance of fertility, may be attained if grass is grown for a 4- to 5-year period during each 12- to 15-year cycle. In most parts of this zone, crested wheat grass, seeded into clean stubble and used for hay or pasture, has been most satisfactory. In the northern section of the brown soil zone, brome grass, alfalfa, and crested wheat grass have been grown successfully for seed production. Mixtures of brome and alfalfa or crested wheat grass and alfalfa have been grown for forage.

Early cultivation of fallows with a combination of well adjusted disc- and subsurface-type tillage implements provides for best weed control and moisture conservation consistent with safety against soil drifting. A properly adjusted one-way disc, a blade cultivator, and a rod weed have proved useful for normal fallow operations.

Wherever possible, at least some livestock should be kept to utilize non-arable grassland, cultivated grasses from rotations and sparse crop growth during drought years. These practices lend a measure of stability and permanency.

THE DARK BROWN SOIL ZONE

The soil and climatic conditions in the dark brown soil zone permit a wider variety of crops and cropping practices than in the brown soil zone. Along the border of these two zones the system of farming most likely to succeed is similar to that used in the better parts of the brown soil zone.

This is primarily a wheat-producing area and every effort must be made to maintain its productivity at a high level through proper cropping practices.

A rotation of wheat-wheat-fallow is most commonly used and experimental results at Lethbridge indicate that returns from this rotation often are better than from the wheat-fallow system. Continuous cropping to wheat has not been economically practical because of drought years when no crop was obtained. Barley and oats may replace wheat in most areas and often serve as a second or third crop after fallow. Flax produces good yields in the central and southern parts of this zone but to avoid disease infestation, it should not be grown two years in succession on the same land. Durum wheats of good quality may be grown in the south end of the zone. In the area south and west of Lethbridge, winter wheat may replace spring wheat in most rotations. Commercial mustard, best grown under

contract, does well in the south part of the zone.

Cover crops of wheat, oats or barley, seeded during July, provide needed protection to fallows on soils subject to drifting in the central part of the dark brown soil zone.

Periodic seeding-down of cultivated land to grass or grass-legume mixtures, thereby extending the rotation period, is desirable. Inclusion in the grain crop of sweet clover for green manuring the following year appears to be beneficial where annual precipitation exceeds 16 inches.

Good trash-cover fallows prepared early in the season and maintained through the summer with a combination of disc and subsurface tillage implements generally provide for best weed control and moisture conservation consistent with safety from soil drifting. Plowed fallows cannot be recommended for the chinook area of this zone.

The inclusion of livestock and forage crops tends to add stability to farms in this zone.

BLACK SOIL ZONE

Because of their greater moisture efficiency the black soil areas permit the use of more intensive cropping systems. A full year of summerfallow is costly and not necessary for moisture conservation, especially in the moister parts. However, it is used to some extent for the control of certain persistent weeds.

The moister of the deep black soils of this zone lend themselves more to mixed farming and the use of longer rotations involving the growth of coarse grains and forage crops, rather than to straight grain production. Barley and oats are the best grain crops in the moister parts of the region, while grass-legume mixtures give the greatest forage yields. A "partial" sumerfallow in the year of breaking out of sod is usually employed.

The length of the rotation and the proportion of grain to forage depend on the operator's requirements for livestock feed and upon the local soil condition. The value of grass-legume mixtures for the improvement of soil tilth, the control of erosion and the suppression of weeds has been amply demonstrated. Based on productivity, a brome-alfalfa mixture is best suited to these soils when left down for a period of 3-5 years.

The beneficial effects on productivity of the mixed farming type of rotation over the straight grain rotation are clearly illustrated by the resulted presented below, from a comparative study conducted at Lacombe over a 35 year period.

Period	Rotation "C" Wheat, wheat, fallow Yield of grain in lb./acre of rotation	Rotation "O" Potatoes, wheat, oats, fallow, wheat, hay, hay Yield of crop in lb./acre of rotation		
		Grain	Hay	Potatoes
1923-32	876	801	1,012	1,944
1933-42	615	906	913	2,136
1943-52	862	1,076	755	2,757
1953-57	826	1,018	597	2,229

Where forage crops are grown for soil improvement alone, a shorter rotation having 3-4 years of grain with sweet clover in lieu of fallow may be used to attain similar results. The sweet clover could be taken off as hay or plowed down as green manure with equal results.

In the drier portions referred to as the thin black soils, grain production, chiefly wheat, predominates. In this area the summerfallow is used extensively, both for weed control and moisture conservation. A grain-fallow rotation with periodic seeding down to forage is a more practical type of cropping system for this area. (See references.)

GREY WOODED SOIL ZONE

Legumes are essential to productivity of grey wooded soils. A number of legumes including red clover, alsike and sweet clovers and alfalfa may be grown alone or in combination with various grasses.

The moister regions of this zone are generally very favorable to crop production. Summerfallow should be used only for the control of weeds that can not be controlled by chemical spraying.

Two to three years of legume or legume-grass and two to three years of grain constitute the main rotations on these soils. A short rotation of grain seeded down, legume plowed down as green manure and grain may be desirable to more quickly improve soil that has not previously been sown to legumes. After several rounds of this rotation, a longer, more permanent rotation could be established.

A number of grey wooded soils of West-Central and North-Central Alberta are sulphur deficient. On these soils the use of sulphur-bearing fertilizers on legumes is necessary to obtain the full benefit of the legume crop. Results from the University Soils Department plots at Breton for the period 1930-53 clearly show this effect.

Fertilizer	Wheat after fallow	Wheat after clovers
None	17.6 bu.	14.7 bu.
Sulphur (21-0-0)	24.5* bu.	32.6 bu.

*Increase due primarily to N rather than sulphur.

The wheat yielded less after clovers than after fallow when no sulphur was applied. When sulphur was applied, the wheat after clovers yielded 14.3 bushels per acre more than

wheat after fallow. For more detalis on sulphur and other fertilizers on these soils see page 15 on Soils, Zonation and Fertility. (See references)

IRRIGATED SOILS

Irrigation farmers have ample opportunity to use well-planned rotations because of the wide choice of crops that can be grown and the assurance of a proper supply of moisture. The choice of crops is entirely up to the farmer, although perhaps limited in some cases by the availability of contracts for certain of the specialty crops. Summerfallow has no place in irrigated agriculture except when a very serious weed problem or land-levelling program may justify its use.

The livestock farmer should grow forage crops in his rotations. Alfalfa has proved a very valuable crop in improving the fertility and physical conditions of a soil. Livestock provides an outlet for such unmarketable products as beet tops, corn stovers and pea vines. It also supplies manure which is by far the best fertilizer. Manure should be applied to the fields in early fall and plowed under to enable it to decompose as completely as possible before the following crop is sown. The most remunerative crops, such as sugar beets, should follow on the manured fields. Farmers who do not keep livestock should plan to grow a legume crop for plowing under as green manure.

Barnyard manure, green manures, and commercial fertilizers build up fertility, so that succeeding crops will benefit. It is well to plan the fertilizer program in such a manner that the greatest net returns per acre can be expected from year to year. For example, sugar beets should be grown on manured fields as this crop responds well to the application of barnyard manure. Commercial fertilizers should also be applied with sugar beets and canning crops as these will usually give the greatest returns. If cereal crops follow, they will benefit from the residual manure and fertilizer that are in the soil and may not require additional fertilization. (See also Section on Fertilizers.)

The five rotations outlined are types that may be followed in the irrigation areas.

1. Very intensive farming, sugar beets, canning crops and forage crops.
   (1) Canning peas—50 lb. 11-48-0—manure stubble and plow under in the fall.
   (2) Sugar beets—100 lb. 11-48-0.
   (3) Canning corn—100 lb. 16-20-0.
   (4) Soft spring wheat as companion crop for alfalfa or alfalfa-brome mixture.
   (5) Hay 1.*
   (6) Hay 2.
   (7) Hay 3.
   8) Potatoes—100 lb. 11-48-0.

*If alfalfa alone, 100 lb. 11-48-0 in early spring.
If alfalfa-brome, 100 lb. 27-14-0 in early spring.

2. Sugar beets and hay crops.
   (1) Soft spring wheat as companion crop for alfalfa or alfalfa-brome mixture.
   (2) Hay 1.*
   (3) Hay 2.
   (4) Hay 3.
   (5) Soft spring wheat or other grain—manure stubble and plow under in the fall.
   (6) Sugar beets—100 lb. 11-48-0.
   (7) Sugar beets—100 lb. 11-48-0.

*If alfalfa alone, 100 lb. 11-48-0 in early spring.
If alfalfa-brome, 100 lb. 27-14-0 in early spring.

3. Cash crops without forage crops.
   (1) Canning peas—50 lb. 11-48-0.
   (2) Potatoes—100 lb. 11-48-0.
   (3) Sugar beets—100 lb. 11-48-0.
   (4) Grain and sweet clover.
   (5) Plow sweet clover for green manure about May 20 and plant canning corn—100 lb. 16-20-0. (If manure available, plow under with pea stubble.)

4. Irrigated pasture with limited contract crops.
   (1) Grain.
   (2) Pasture seeded in stubble.
   (3) Pasture.*
   (4) Pasture.
   (5) Pasture*
   (6) Pasture—break in fall.
   (7) Grain—manure stubble and plow under in fall.
   (8) Row crop or specialty seed crop.

*100 lb. 11-48-0 in early spring. Additional nitrogen may be used later in the season.

5. Grain and hay production — no contract crops.
   (1) Grain and alfalfa.
   (2) Hay—100 lb. 11-48-0.
   (3) Hay—manure in early spring.
   (4) Hay—100 lb. 11-48-0.
   (5) Grain.

TILLAGE

About two-thirds of all power in farm draft is expended in tillage.

The principle objectives in tillage are:

1. To improve soil tilth.
2. To control weeds and conserve moisture.
3. To develop a desirable soil structure for a seed or root bed.

Other objectives are:

1. To control insects, disease and erosion.
2. To prepare land for irrigation.

3. To incorporate crop residues, fertilizers or soil amendments into the soil.

Some of these objectives conflict and compromises are often necesary in individual situations.

For best results, timeliness, suitable implements, proper adjustment and operation are important. Lack of attention to these requirements can result in wasted effort and actual damage.

There are many types of tillage implements, and the one selected for any particular operation should depend upon field characteristics, vegetation, weather conditions, topography and other factors. (See section on tillage machinery, page 154.)

Summerfallow is designed to control weeds and conserve moisture for the following crop. Therefore begin cultivation early in the spring and keep weed growth to a minimum.

Use a combination of implements and methods that will result in the maximum amount of stubble and trash remaining on the surface of the soil at the time of the next seeding.

A light stubble requires more care to preserve it. Sub-surface implements such as rod and blade weeders should be used. For heavy stubble, discers and one-way discs may be used for the first operations.

Cultivation generally should be on the shallow side; deeper than three to four inches is seldom justified. This depth is usually required to provide adequate weed control.

Fall cultivation of stubble is used to control perennial weeds, germinate annuals, control insects or to reduce an excessively heavy trash cover. It is recommended that the stubble remain standing after cultivation to trap winter snow.

SEEDING

Various types of equipment are available for seeding. Most common of these are the standard drill and the tiller combine or disc type of seeder.

The double disc press drill or the standard double disc drill followed by a good packer is the best implement for most conditions. This is particularly true where some pre-seeding tillage has been done and the soil is already fairly loose. The double disc drill gives uniform depth of seeding and can be adjusted for shallow sowing of forage seed.

The one-way disc type of seeder is useful for seeding stubble land or very firm summerfallow. If soil conditions vary or if the field is not reasonably level it will be difficult to maintain a uniform depth. The chief advantage of this implement is that it combines tillage and seeding operations and so reduces operating costs. This type of seeder must be followed by a heavy packer.

In the brown soil zones and wherever a heavy trash cover is essential the high trash clearance hoe drill can be very useful. This implement, with its wide spacings, permits seeding into heavy trash cover without clogging.

Dates of seeding vary considerably within the province depending upon location and season. It is usually safe to be guided by the general practice in the district.

Wheat and other late maturing crops such as mustard must be sown fairly early. Coarse grains require a shorter growing period. Oats and barley therefore, can be sown later, which permits pre-seeding tillage. This is a distinct advantage in the control of weeds. Olli barley, an early variety, has given best results in the Edmonton area when sown during the first week in June.

As flax requires a long growing season it should be seeded fairly early. However, since flax is subject to severe damage by spring frosts, seeding should be delayed sufficiently to avoid freezing of the flax seedlings. In Central Alberta flax seeding is usually finished about the 15th of May—seldom later than the 20th for best results.

Rates of seeding will usually be heavier where moisture is more abundant and lighter in the drier soil zones. In tests at the Lacombe Experimental Farm slight reductions in the rate of seeding did not give corresponding reductions in yield. This would indicate that lighter seeding should be considered wherever possible. However, a heavier rate of seeding provides more competition to weeds and is therefore recommended where weed control is a problem. Ranges in seeding rates are as follows:

Name	Bu. per acre
Wheat	¾-2
Oats	1½-3
Barley	1½-2½
Rye	¾-1½
Durum	1¾-2¼
Name	**Pounds per acre**
Flax	30-40
Mustard	3-5
Rape	8-10

Depth of seeding should be kept to a minimum. Sow deep enough to place the seed in moist soil and no more. The use of a packer or press drill will assist in bringing moisture closer to the surface, permitting shallower seeding. The best depth for cereal grains is 1 to 2 inches. Never seed deeper than three inches as reduced yields usually result. Mustard and rape seed should be sown from ½ to 1½

inches deep. Forage seeds should be planted no more than ½ to 1 inch deep.

USE GOOD SEED

Only by using good seed of suitable variety can a farmer produce most profitably. Pedigreed, high grade seed means varietal purity and uniform results in the field. It also means high germination and freedom from weeds and disease. Low grade seed means reduced yield and quality.

If using your own seed, select the best and obtain a germination test. A representative one pound sample taken to your elevator agent will be sent to a recognized laboratory for testing.

Cleaning is important. This can best be done by a reputable seed cleaning plant. Alberta is well served with good cleaning plants, having some 26 municipal and numerous privately owned plants thoughout the province. More are being built each year. In addition to cleaning, the seed should be treated with a recognized seed protectant. The job of testing, cleaning, and treating seed should not be left until spring. It should be done early in the winter when facilities are more readily available.

HARVESTING

Different crops require different methods. The combine has largely replaced the binder-thresher method because of the saving in time and labour. The crop can be straight combined or picked up from a swath. Swathing permits earlier threshing, thereby reducing risk from weather and insects and eliminating green weeds in threshing.

CEREAL CROPS

Swathing should be started when the grain has a moisture content of 35 to 40 per cent (when the kernel can be dented easily with the thumb nail). The crop should be combined as soon as the grain has dried sufficiently.

The highest moisture content allowed for straight grades and storage is:

Wheat 14.5%, durum wheat 14.8%, oats 14%, barley 14.8%, rye 14%, flax 10.5%.

Malting barley should be in the firm dough stage before swathing and it should be combined as soon as possible. Special attention must be given to combine adjustments. (See section on harvesting machinery, page 156.)

FORAGE AND SPECIALTY CROPS

In harvesting special crops such as grass and legume seed, rape and flax, special attachments and adjustments to the implements will be required. Information on harvesting these crops can be obtained from District Agriculturists or Experimental Farms in your district. (See also section on forage crops, page 49.)

References:

University of Alberta, Edmonton
Bull. 44—Cropping for Profit and Permanency.
Bull. 21—Wooded Soils and Their Management.

Experimental Farm, Lacombe
Progress Report 1947-1952.

Experimental Farm, Beaverlodge
Progress Report, 1948-1952.

Weed Control

Weeds cause the farmer greater losses than any other production hazard. They compete strongly with crops for moisture, food and light. Successful crop production in Alberta depends on moisture conservation and this can only be accomplished by good weed control. Weeds increase production costs and decrease land values.

CLASSIFICATION BY GROWING HABITS

Annuals—grow from seed in the spring or summer, produce seed and die in the same season. (e.g., wild oats, hemp nettle, lamb's quarters).

Winter Annuals—begin growth in the fall, live over winter and produce seed the following year. Stinkweed and some others may grow as either annuals or winter annuals.

Biennials—require two seasons to produce seed. They begin growth in the first year, start from their roots in the following spring, produce seed and die. (e.g., goatsbeard).

Perennials—live for more than two years and reproduce from seeds or roots, or both. The roots are dormant over winter and start new top growth every spring. (e.g., Canada thistle, couch grass, leafy spurge).

GENERAL RECOMMENDATIONS FOR THE CONTROL OF ANNUAL, WINTER ANNUAL AND BIENNIAL WEEDS

These weeds can be controlled best by reducing the number of seeds in the soil. Proper tillage, sound seeding practices, herbicide use and planned cropping systems will do much to prevent their seeding and re-infecting the soil.

TILLAGE AND SEEDING:

Till before seeding to destroy as many weeds as possible and till only deep enough to kill existing weed growth. Deep tillage at this time reduces the strength and vigor needed by the seedling crop to compete with weeds.

Sow only sound, well cleaned seed, and place it in firm, moist soil. Seeding with a press drill, or packing, harrowing or rod weeding right after seeding, will hasten germination.

Recommended fertilizers often reduce weed competition by stimulating crop growth. On land heavily infected with weed seeds, sowing 25% more grain will reduce weed competition.

In seasons when weeds have emerged before the crop has sprouts more than one-half inch long, shallow rod weeding or harrowing after seeding will give good weed control.

HERBICIDES:

(See section on Chemical Weed Control).

SUMMERFALLOW PRACTICES:

(a) Fall tillage is recommended only where there are heavy infestations of winter annuals and biennials resistant to 2,4-D. Some annuals such as wild oats germinate more readily in the spring if lightly tilled late in the fall.

(b) Tillage of fallow in the spring should begin as soon as weed growth warrants, but it should have regard for the control of wind and water erosion.

(See soils section).

(c) Partial fallow, after a crop of hay has been removed, can help to control such weeds as couchgrass and Canada thistle.

COMPETITIVE CROPS:

(a) Barley and rye compete strongly with weeds. Flax is a poor competitor. Barley is useful in a wild oat control program.

(b) The seeding down of forage crops in a more or less regular pattern will help in the fight against weeds.

GENERAL RECOMMENDATIONS FOR THE CONTROL OF PERENNIAL WEEDS

Seedling perennial weeds are controlled like annuals. However, once established, the root system as well as the top growth must be destroyed.

The root system of a perennial plant serves both as a means of spreading and as storage for food.

Spreading is effected by buds on the underground rootstock. A piece of root containing a bud is capable of initiating a new plant. Extreme caution should be taken to prevent spreading root pieces with tillage machinery.

The roots store the food manufactured by the leaves. The food in the roots is partially used for the new growth from the root buds. If this leaf growth is restricted by repeated or intensive tillage, the roots will eventually die of starvation. Intensive tillage of fallow means tillage operations done often enough to prevent the appearance of green regrowth for more than 6 to 8 days.

Intensive tillage tends to destroy the trash cover rather rapidly and to pulverize the soil. Strip cropping and the use of implements that ridge the soil and do not unduly cut up and bury the trash help to combat erosion. Herbicides may be used as a substitute for part of the tillage in the control of some perennials.

PRECAUTIONS

1. Prevent the spread of weed seeds in the movement of farm machinery, livestock, grain, hay, screenings and soil.

2. Watch for unfamiliar weeds. Specimens, preferably in flower and including part of the root, should be sent for identification to your District Agriculturist, nearest Experimental Farm, the University of Alberta or the Department of Agriculture, Edmonton.

3. Community effort is essential to successful weed control. Support your weed inspector or Field Supervisor in his job of controlling weeds.

CHEMICAL WEED CONTROL

Control of Weeds in Field Crops:

Early treatment of the grain crops with selective herbicides such as 2,4-D and MCPA will kill susceptible weeds and increase crop yield. Young weeds are easier to kill with recommended rates of chemical.

Spring Wheat and Barley

The ester type of 2,4-D is most extensively used in Alberta for the control of weeds in spring wheat and barley. These grains may be treated safely as soon as the fourth leaf appears or when the plants are about 6 inches high under normal growing conditions. Treatment can be made safely until the early boot stage (shot-blade) and again from the soft dough stage to maturity.

MCPA is safer if weed spraying is necessary before the three-leaf stage.

Oats:

Oats have proved tolerant to MCPA at all stages of growth except from early shot-blade to the soft dough stage. So this chemical may be applied as soon as weed conditions warrant.

Oats are sensitive to 2,4-D particularly the ester type, and are frequently damaged by its use. If 2,4-D is used to control weeds resistant to MCPA, use the amine formulation. With 2,4-D amine, treatment should be made between emergence and the two-leaf stage or between the six-leaf and early boot stage.

Flax:

Flax may be treated safely with 2,4-D or MCPA from the time the plants are 2 inches high (three to four-leaf stage) until the bud stage, but not later. For best results this crop should be treated early, as soon as there is enough emergence of susceptible weeds to make it practical.

Flax is more tolerant to MCPA than to 2,4-D. MCPA is therefore preferable except for control of more resistant weeds, such as Russian thistle. In such cases 2,4-D ester should be used, although delayed maturity some damage to the flax may occur.

The sodium salt of TCA at 4 to 6 lb. acid per acre may be used to control green foxtail in flax. The TCA may be applied anytime from emergence of the weed until it is 2 inches tall. TCA may be combined with MCPA or 2,4-D, at the recommended rates for these herbicides, to control both green foxtail and broad-leaved weeds with the one application. Treatment with TCA may result in some reduction in yield unless weed competition is reduced sufficiently to compensate for the injury.

Winter Wheat and Fall Rye:

Treatments at the rates recommended for annual and winter annual weeds should be applied in the spring as soon as weed growth warrants.

Alfalfa, Red Clover and Alsike Clover:

Newly-seeded stands of these crops should not be treated unless the legume stand is vigorous and dense and weeds are a serious threat.

Alfalfa, red clover or alsike clover (not sweet clover) sown with or without a companion crop of grain can be treated with MCPA amine at 2 to 4 oz. or MCPA sodium salt at 3 to 6 oz. per acre. These legumes are least sensitive at the second true leaf stage. Selective dinitro compounds may be used at 12 to 20 oz. in 80 gal. of water per acre.

Early germinating annual weeds, such as Russian pigweed, can be controlled in established stands of alfalfa seed crops by treating with 2,4-D or MCPA ester at 8 to 16 oz. per acre before growth starts in the spring. If treatment is delayed until the alfalfa is one inch high, the rates should be reduced. No treatment is recommended after the alfalfa is 4 inches tall.

Sweet Clover:

Sweet clover is susceptible to 2,4-D and MCPA and may be injured my drift of these chemicals. Drift at time of flowering is particularly damaging to seed production.

Peas:

Field and canning peas, when 4 to 8 inches high, may be treated for control of broad-leaved annual weeds with the following:

MCPA sodium or potassium salt at 2 to 6 oz. per acre in as low as 5 gal. of water per acre.

MCPA amine at 2 to 4 oz. per acre in not less than 15 to 20 gal. of water per acre.

Grasses: (Brome, Crested Wheat, Creeping Red Fescue and Kentucky Bluegrass)

Once the three-leaf stage has been reached,

new seedings of grass may be treated with up to 8 oz. of 2,4-D ester per acre without harm. Established grass stands can tolerate heavier dosages, the rate needed depending on the weed species. Seed yields of grasses may be reduced by the use of 2,4-D just before and at flowering.

Sweet clover may be removed from grass stands with 8 oz. per acre of 2,4-D ester when the legume is about 8 inches tall.

Lawns:

New lawns may be sprayed with 2,4-D or mixtures of 2,4-D and 2,4,5-T once the grass plants have developed three leaves. Established lawns may be sprayed whenever weeds are showing vigorous growth, preferably in late May. Dandelions should be treated just before flowering.

To control dandelions and most broadleaved weeds in established lawns use 2,4-D amine at 16 oz. per acre. For each 1,000 square ft. of lawn, this rate works out to 1½ tablespoons of chemical containing 80 oz. of acid equivalent per gal. or 2 tablespoons of chemical containing 64 oz. acid equivalent per gal. Injury to bent grasses may result from the above treatment. Some damage may be done to white Dutch clover by 2,4-D but it usually recovers completely.

Care must be taken to prevent the chemical drift from reaching susceptible plants. Use a watering can or a knapsack sprayer at low pressure to provide a coarse spray.

Pasture and Range:

Selective chemicals may be used for weed and brush control on native grass pastures, waste land or cultivated pastures that do not contain legumes. Treatment with 2,4-D ester at 1 to 2 lb. per acre is recommended. For rosebush use a mixture of 2,4-D and 2,4,5-T. More than one application may be necessary. (See also control of woody plants.)

Uncultivated Lands, Fencelines and Barnyards

Soil sterilants may be used to remove all growth, to prevent the spread of a troublesome weed, or to create a clean area for implement storage. Such chemicals as chlorate and borate-chlorate compounds at 3 to 4 lbs., or monuron (CMU) at 2 oz. per 100 sq. ft. will effectively denude small areas of vegetation. Monuron is particularly desirable for removing grass and weeds along fencelines as it will leave a neat verge. These compounds should not be used near trees. Nor should they be allowed to seep into water intended for domestic or irrigation uses.

Rates of Chemicals for Crops:

The quantity of active ingredient to use within the ranges recommended in the table below will be influenced by (1) stage of weed growth, (2) kind of weed, and (3) growing conditions. Annual and biennial plants are most susceptible when young. Established perennials are generally less suspectible than annual weeds, with best results being obtained if the chemical is applied at the early bud stage. The wide variation in the susceptibility of weeds to chemicals is reflected in the Weed Classification table. Weeds are more susceptible to 2,4-D and MCPA under conditions of rapid growth.

The higher rates in each group are recommended during advanced growth stages of weeds, under drier conditions, and when crops are heavily infested with weeds. The rates shown in brackets in the table may cause injury to the crop, but this will frequently be less serious than the losses caused by weeds if untreated.

Rates of Applying Chemicals

This table gives the recommended rates of applying 2,4-D and MCPA in water spray for the control of weeds in growing crops.

Note: — All rates are expressed as acid equivalent. For example, one gallon with 64 ounces acid equivalent will treat 16 acres at the rate of 4 oz. acid equivalent per acre.

Control Of Specific Weeds

ANNUALS

Wild Oats:

Cultural methods must be relied on for the control of this weed since to date a satisfactory herbicide has not been discovered. Unfortunately, the success of cultural methods of control is very dependent upon the weather.

Delayed seeding is the best method for controlling wild oats. The surface should be tilled to a depth of not more than four inches early in the spring to promote germination. Seeding should be delayed until after maximum emergence of wild oats has occurred.

Crop	Formulation 2,4-D	Ounces Acid Equivalent Per Acre Group I Weed	Weed Group II	Weed Group III	Weed Group IV	Weed Group V
Wheat, Barley	Ester	3 to 4	4 to 6	6 to 8	(9 to 12)	(12 to 16)
Rye and Corn	Amine	4 to 5	5 to 7	7 to 9	(10 to 14)	(15 to 20)
° Oats	Amine	4 to 5	5 to 7	(7 to 9)		
° Flax	Ester	3 to 4	(4 to 6)	(6 to 8)		
	Amine	4 to 5	(5 to 7)	(7 to 9)		
	MCPA					
Oats (Wheat, Barley, Rye and Corn)	Ester	3 to 4	4 to 6	6 to 8	(9 to 12)	(12 to 16)
	Amine	4 to 5	5 to 7	7 to 9	(10 to 14)	(15 to 20)
	Sodium Salt	5 to 6	6 to 8	8 to 10	(11 to 15)	(15 to 20)
Flax	Ester	3 to 4	4 to 6	(6 to 8)	(9 to 12)	
	Amine	4 to 5	5 to 7	(7 to 9)	(10 to 14)	
	Sodium Salt	5 to 6	6 to 8	(8 to 10)	(12 to 15)	
Alfalfa, red & Alsike Clover	Amine	2 to 4 in 15 to 20 gals. water per acre				
	Sodium Salt	3 to 6				
Peas	Amine	2 to 4 in 15 to 20 gal. water per acre				
	Sodium Salt	2 to 6				

° For emergency use only. Considerable reduction in crop yield can be expected particularly where the heavier rates (in brackets) are used.

Where the above chemicals are applied in a dust carrier, it is generally advisable to use up to 1/3 more acid per acre than the rate recommended in a water spray. (See Farm Machinery section for spraying and dusting equipment).

WEED CLASSIFICATION ACCORDING TO RESPONSE TO 2,4-D AND MCPA

GROUP I — Very Susceptible
Wild Mustard

GROUP II — Susceptible annuals (require higher dosages than Group I).

Ball Mustard	Lamb's quarters	Common ragweed
Stinkweed	False ragweed	Sunflowers (Gr. III for MCPA)
Great ragweed	Tumbling mustard	Hare's ear mustard
Wormseed mustard	Indian mustard	

GROUP III — Moderately susceptible (Susceptible in early growth stages. May become less susceptible under adverse conditions and/or advancing growth).

Blue Bur	Stinging nettle	Gumweed
Burdocks	Goatsbeard	Cocklebur
Shepherd's purse	Common plantain	Sweet clover (Gr IV for MCPA)
Dandelion (in lawns)	Russian pigweed	Prickly lettuce
	Wild radish	

GROUP IV — Moderately resistant (Under adverse conditions and/or with advancing growth become resistant). Perennials require retreatment.

Prostrate amaranth	Quickweed	Alfalfa
Pepper grass	Biennial wormwood	Perennial sow thistle (Group V for MCPA)
Blue lettuce	Prairie thistle	Common chickweed
Canada thistle	Purslane	Russian thistle (Gr. V for MCPA)
Red root pigweed	Common groundsel	Dandelion (in fields)
Curled dock	Spear-leaved goosefoot	Field bindweed
Dog mustard	Smartweeds	Tartary buckwheat
Tall buttercup	Hedge bindweed	Pineapple weed
Hoary Cress	Wild buckwheat	
	Annual sowthistle	

GROUP V — Consists mainly of perennial weeds of which generally only the top growth is controlled with 2,4-D or MCPA.

Field horsetail (Gr. IV for MCPA)	Scentless mayweed (Resist to MCPA)	Hemp nettle (Gr. IV for MCPA)
Russian knapweed	Leafy spurge	Creeping buttercup (Gr. IV for MCPA)

GROUP RESISTANT TO 2,4-D and MCPA (Control impossible or impractical with these chemicals)

Bracken	Bladder campion	Tansy
Cow cockle	Night flowering catchfly	Poverty weed
Grasses	Ox-eye daisy	Purple cockle
Shrubby cinquefoil	Knotweed	Pasture sage
Stinking mayweed	White cockle	Milkweed
Yarrow	Cacti	Shield cress
Wild liquorice	Toadflax	

In most localities seeding can be delayed until the first week in June if necessary. Pre-seeding tillage to kill wild oats is best done in dry, hot weather, and should not go below 4 inches, otherwise fresh wild oat seed will be brought up to further infest the crop. If the soil is moist, seed as shallow as possible. An early maturing barley is the most suitable crop and should be seeded at a slightly heavier rate and a little deeper than is normal. Fertilizer will help to ensure best results.

Flax should not be seeded on wild-oat-infested-land.

Post-seeding Cultivation

Rod weeders, cable weeders or harrows can be used to advantage to destroy wild oat plants after the crop has been seeded. Seeding should be done a little deeper than normal. Begin cultivation when the sprout on the grain crop is one-half inch long. (To be effective.) The surface soil must be dry and relatively free of trash and the weather bright and warm.

Fall Cultivation

Shallow tillage of stubble to cover wild oat seeds is a good practice in heavily infested fields. The cultivation should be done after the new seeds have had an opportunity to dry — usually in late September or early October. This tillage will provide a seedbed for the wild oats and promote rapid germination in the spring. The machine used will differ with the various soil types.

Cropping Methods

(a) GREEN FEED crops, such as oats, for forage, cut prior to heading of wild oats afford a good measure of control. Wild oats if headed when cut will mature in the sheaf and seeds will be spread in feeding. (b) FALL SEEDED crops such as fall rye can be used to advantage in conjunction with crops of green feed and late seeded early maturing barley in a cleaning up rotation. (c) FORAGE CROPS— Grasses and legumes left down for some years will do much to lessen the incidence of wild oats.

Wild Buckwheat

Infestations can be reduced by good cultural practices. Delay seeding until the early-emerged wild buckwheat has been destroyed by tillage. Harrowing or rod weeding after seeding will give further control.

Chemicals can be used to control or suppress wild buckwheat in growing cereal crops. Best results are obtained from two applications of 2, 4-D ester at 5 oz. per acre each. The first application should be made not later than the second true-leaf stage of the buckwheat with the second one week later. If, at this stage, the grain is too small for safe treatment with

2, 4-D use MCPA ester. In oats use MCPA ester at 5 oz. per acre for both treatments.

A single treatment at the highest recommended rate for the crop being sprayed will give a fair measure of control.

Tartary Buckwheat

Tillage and cropping practices used for other annual weeds apply also to tartary buckwheat. For chemical control in wheat and barley, treat with 6 to 8 oz. of 2, 4-D ester per acre as soon as crop growth permits. Low volatile 2,4-D esters give better control. MCPA at 12 to 16 oz. per acre is better for oats and flax. These rates will reduce growth and seed set but will not eradicate the weed.

PERENNIALS

Couch Grass (quackgrass, twitchgrass)

Cultivation is the only practical method of controlling large scale infestations of couch grass. Thorough tillage such as reasonably deep plowing or one way discing just before freeze up is recommended. In the following year as soon as the grass has resumed growth, cultivation should be continued and repeated throughout the summer months whenever regrowth becomes noticeable. A disc implement should be used to shred the root stalks and starve the plants. If the soil becomes dry and the underground parts become dormant, a cultivator equipped with chisel points followed by a cable or rod weeder should be used to bring the rhizomes to the surface to dry out. Working with a disc implement should be resumed if the soil again becomes moist enough to cause growth of the plants. Care must be taken not to drag pieces of rhizomes to clean parts of the field. During seasons of heavy rainfall which restrict cultivation mowing or grazing to prevent heading is desirable. Heavy pasturing prior to initiating cultivation will facilitate eradication.

On small patches TCA and dalapon can be used as "short term" soil sterilants. On undisturbed sod, 3 to 4 oz. of TCA or about one-half this quantity of dalapon per 100 sq. ft. is usually sufficient. A lower rate of TCA, 2 to 2½ oz. per 100 sq. ft., can be used if the sod is tilled or plowed before application. Dalapon, however, usually works best when applied to the leaves and followed by cultivation after the foliage turns brown. Follow-up cultivations may be necessary for complete kill with either TCA or dalapon. In drier areas the effect of the chemical may extend into the next growing season. This is more likely to happen with TCA than with dalapon.

Sodium chlorate compounds will eradicate couchgrass, but the soil may remain sterile for two or more years. Rates of one or 2 lb. per 100 sq. ft. should be applied in the dry form to reduce the fire hazard when pure sodium chlorate is used.

Monuron (CMU) may be used on non-crop land. It is a very long term soil sterilant. Rates of ¾ to 1½ oz. per 100 sq. ft. should be applied and the soil should not be disturbed for a year. Monuron is safe to handle but should not be used near desirable trees.

Canada Thistle and Perennial Sowthistle

Near-complete to complete eradication can be achieved by a full season of intensive tillage, beginning immediately after harvest and continuing until freeze-up of the following year.

The tillage operations may be discontinued in mid-July and the thistles treated with the ester of 2,4-D at not less than 16 oz. per acre when in the late bud stage. Tillage should recommence as soon as regrowth appears and continue until freeze-up.

The top growth of these weeds can usually be killed and seed formation prevented in grain crops by the use of 2,4-D at the maximum recommended rate for the crop concerned. MCPA may also be used for Canada thistle but is less effective against perennial sowthistle.

Infested areas may be seeded to a suitable and strongly competitive grass. Treating with 2,4-D when the grass has attained the three-leaf stage of growth will weaken the thistles and allow the grass to become established. Annual treatment with 2,4-D throughout the life of the grass stand will reduce the thistle stands. This procedure is best suited to slough edges, roadsides, and other uncultivated areas.

On non-crop land repeat dosages of the ester of 2,4-D at 16 oz. per acre will control, if not eradicate, these weeds. Best results are obtained if treatments are made when thistles are in bud to first bloom. Soil sterilants such as sodium chlorate at 1½ to 2 lb., chlorate-borate compounds at 2 to 3 lb., or monuron (CMU) at 2 oz. per 100 sq. ft. will kill these weeds, but their use is practical only in small patches. Treatment should be made for a distance of not less than 6 feet beyond the limits of the patch.

Field Horsetail

The top growth of this weed can be effectively suppressed by 4 oz. per acre of the ester of MCPA applied when it is completely emerged. At this time the cereal crop will be at an advanced growth stage, and spraying should be done either at early shot blade or at a post-flower stage. 2,4-D can be used in

place of MCPA but there is more chance of injury to the cereal crop.

The annual use of MCPA for top-growth kill of horsetail in cereals will reduce the stand of the weed.

Toadflax, Leafy Spurge, Hoary Cress, Field Bindweed, Russian Knapweed, and Bladder Campion

On crop land, intensive tillage of fallow will reduce the stand of these weeds sufficiently to permit successful crop production the following year. Eradication by continued intensive tillage is possible, but must be continued into the third season. Because of the danger of erosion, cultural methods should be confined to limited areas of relatively narrow strips.

Grass may be seeded on infested areas after a season of intensive cultivation. Yearly spraying with the ester of 2,4-D at 32 oz. per acre will reduce the stand and vigour of these weeds. Such seeding and treating procedure is recommended for poorer crop lands.

Small patches can be controlled by the use of the same soil sterilants mentioned above for thistles, using 1½ times the rates suggested for thistles. Areas treated with soil sterilants should not be cultivated for at least two years, and retreatment should be given if regrowth appears. Should seedlings appear, they may be tilled or treated with a heavy dosage of 2,4-D.

Top growth of leafy spurge, hoary cress, and field bindweed can be controlled in grain crops with the ester of 2,4-D at 6 to 8 oz. per acre.

CONTROL OF BRUSH AND TREES

Brush killing mixtures are generally a combination of 2,4-D and 2,4,5-T. Where all the species to be controlled are susceptible to 2,4-D (see woody plants classification) this chemical is recommended by itself since it is cheaper than 2,4,5-T. Often it is necessary to make at least two treatments. Where mixtures are used the most efficient ratio is usually 2 parts 2,4-D to one part 2,4,5-T. Commercially prepared brushkillers usually contain one part of 2,4-D to one part of 2,4,5-T.

There are three main methods of killing brush and trees with chemical.

Foliage Spraying — Spray as soon as the leaves are fully expanded. Use 2,4-D ester, 2,4,5-T, or mixtures of the two, depending on the species present. Wet all foliage thoroughly using 2 to 4 lb. of total acid equivalent in 10 or more gal. of water per acre.

Over-all Dormant Spraying—This is done during the absence of foliage. A mixture of 2,4-D and 2,4,5-T should be used. Two to 4 pounds of the mixture should be applied in 10 to 15 gal. of diesel fuel per acre.

Basal Bark and Stump Treatment — For basal bark treatment apply the chemical from a height of 2 feet down to the ground line. For stump treatment cover the entire stump. In each case the bark at the ground line and the protruding roots should be wetted until the liquid begins to run off. A solution of 1½ lb. of total acid of 2,4-D ester or mixtures of 2,4-D and 2,4,5-T in 10 gal. of diesel oil is recommended.

When growth is tall spraying may not be effective and cutting becomes necessary. If trees are cut down, treat the stump to stop regrowth.

Classification of Woody Plants According to Their Response to Herbicides

Group 1—Susceptible to 2,4-D

Caragana	Lilac	Saskatoon
Chokecherry	Manitoba Maple	Snowberry
Currants	Pincherry	Spirea
Hazelnut	Poplar Aspen	Willows
Honeysuckle	Poplar, Balsam	Wolfe Willow

Group 2—Resistant to 2,4-D

Shrubby Cinquefoil	Raspberry
Oak	Rose

Group 3—Apparently more susceptible to 2,4,5-T than to 2,4-D

Ash	Bearberry	Dogwood
Hawthorn	Raspberry	Rose
	Caragana	

WARNING REGARDING THE USE OF 2,4-D AND MCPA

1. The chemicals 2,4-D and MCPA are non-poisonous and non-flammable. They are no more corrosive to metal and rubber than water. Excessive breathing of the fumes may cause nausea to some operators.

2. When treating grain fields, care must be taken that dust or spray does not come in contact with shelter belts, garden vegetables or other susceptible plants such as sweet clover. Drift of chemical from dusting or spraying may cause damage for a considerable distance downwind. Most vegetable crops are highly susceptible.

3. Use only amines or low volatile esters of 2,4-D near shrubs, flowers or shelterbelts. This should be done with a sprinkling can in preference to a knapsack sprayer.

4. 2,4-D is extremely difficult to remove from spraying and dusting equipment. Such equipment should not be used to spray insecticides on susceptible plants. However, if this is unavoidable, clean the sprayer thoroughly as outlined in the Insect Pest Section.

5. Do not leave 2,4-D containers near susceptible plants because of danger from fumes.

6. After storage, shake or stir 2,4-D thoroughly before using. Large drums of the chemical may be mixed with a gasoline toggle pump.

REMEMBER! Chemicals are Made to Kill Plants — Make sure that they Kill Only Undesirable Plants.

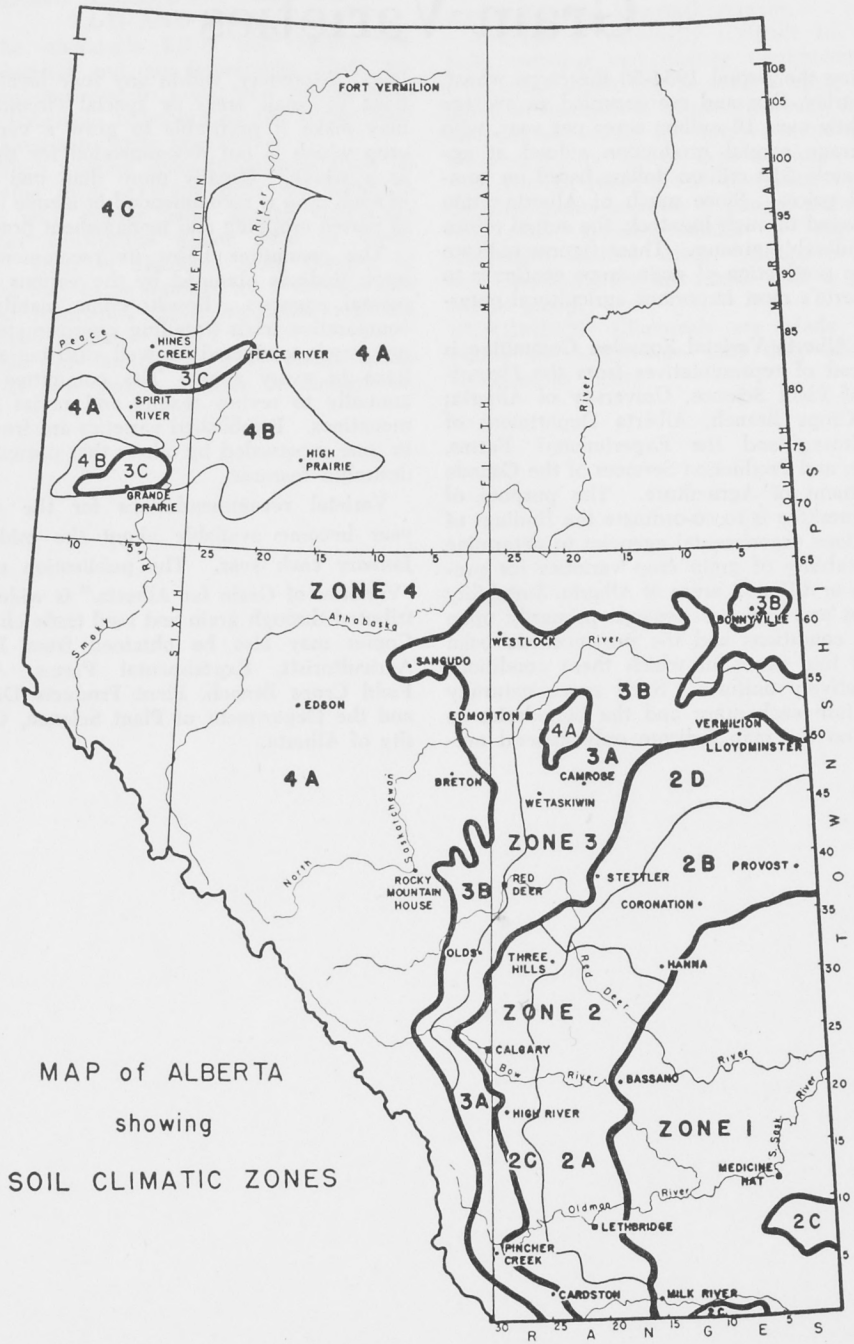
Grain Varieties

During the period 1954-58 the crops wheat, oats, barley, flax, and rye occupied an average of slightly over 12 million acres per year, with an average annual production valued at approximately 318 million dollars based on commercial prices. Since much of Alberta grain is marketed through livestock, the actual return is considerably greater. These figures indicate that the production of grain crops continues to be Alberta's most important agricultural enterprise.

The Alberta Varietal Zonation Committee is composed of representatives from the Department of Plant Science, University of Alberta; Field Crops Branch, Alberta Department of Agriculture; and the Experimental Farms, Science, and Production Services of the Canada Department of Agriculture. The purpose of this committee is to co-ordinate the findings of the various experimental agencies to determine the suitability of grain crop varieties for production in different areas of Alberta. Suitability of crops and varieties depends primarily upon growth conditions and the province has been divided into zones in which these conditions are relatively uniform. Such zones naturally merge into each other and the boundaries as shown on the map indicate only general outlines. Moreover, within any zone local conditions in small areas or special circumstances may make it profitable to grow a variety or crop which is not recommended for the zone as a whole. Usually more than one variety of each crop is recommended in a zone because of varied cropping and management practices.

The committee bases its recommendations upon findings obtained by the various experimental agencies. Results come mainly from comparative trials (totalling approximately 200 per year) conducted at well distributed locations in every zone. The committee meets annually to review results and revise recommenations. Established varieties are from time to time superseded by others that possess more desirable features.

Varietal recommendations for the current year become available about the middle of January each year. The publication entitled "Varieties of Grain for Alberta," is widely distributed through grain and seed trade channels. Copies may also be obtained from District Agriculturists, Experimental Farms, Alberta Field Crops Branch, Plant Products Division, and the Department of Plant Science, University of Alberta.



MAP of ALBERTA

showing

SOIL CLIMATIC ZONES

GRAIN VARIETIES

VARIETIES RECOMMENDED FOR 1959
(Varieties are listed in alphabetical order, not according to merit or desirability)

Zones	Spring Wheat	Barley	Oats	Flax
1	*Chinook *Rescue Thatcher	Compana Vantage	Eagle Exeter	Redwood Rocket
2A	*Chinook *Rescue Thatcher	Compana Vantage	Eagle Exeter	Redwood Rocket
2B	*Chinook Lake *Rescue Thatcher	Husky Parkland	Eagle Rodney	Redwood Rocket
2C	*Chinook *Rescue Thatcher	Compana Husky Parkland Wolfe	Eagle Garry Rodney	Redwing Redwood Rocket
2D	Selkirk Thatcher	Gateway Husky Parkland	Eagle Garry Rodney	Redwing Redwood Rocket
Zones Irrigated Areas	**Spring Wheat** Selkirk Thatcher	**Barley** Harlan Wolfe	**Oats** Eagle Rodney	**Flax** Redwood
3A	Saunders Thatcher	Gateway Husky Olli Wolfe	Eagle Garry Rodney	Redwing Redwood Rocket
3B	Saunders Thatcher	Gateway Husky Olli Wolfe	Eagle Garry Rodney	Redwing Redwood Rocket
3C	Saunders Thatcher	Gateway Husky Olli	Abegweit Victory	Marine Redwing Rocket
4A	Saunders Thatcher	Gateway Husky Olli	Eagle Garry Larain	Redwing Rocket
4B	Saunders Thatcher	Gateway Husky Olli	Abegweit Victory	Marine Redwing Rocket
4C	Saunders Thatcher	Gateway Olli	Abegweit Exeter Victory	Marine Redwing Sheyenne

*Sawfly resistant—see description.

Wheat

HARD RED SPRING WHEAT

THATCHER is a high yielding variety of wide adaptability. It is resistant to lodging and highly resistant to shattering. The kernels are small, have a tendency to bleach and may be low in bushel weight under dry conditions. Thatcher is resistant to most races of stem rust (except 15B), but is susceptible to leaf rust and bunt.

LAKE compared with Thatcher is later in maturity, has longer straw, is equal in lodging resistance and has larger kernels that show less tendency to bleach. It has done well in zone 2B, but is not recommended further north because of its late maturity. It is resistant to bunt and most races of stem rust (except 15B), but is susceptible to leaf rust.

SAUNDERS is earlier maturing than Thatcher, and is generally slightly lower yielding except in the Peace River area. It is equally resistant to lodging and does not shatter readily. Saunders is resistant to most races of stem rust (except 15B), moderately resistant to bunt, but is susceptible to leaf rust.

SELKIRK is slightly earlier than Thatcher and compares favourably in yield and lodging resistance, but has a larger, less attractive kernel. It is resistant to stem rust (including 15B), bunt, and moderately resistant to leaf rust.

CHINOOK and RESCUE are similar to Thatcher in maturity, less resistant to shattering and lodging, and lower yielding. Both are resistant to the wheat stem sawfly and most races of stem rust (except 15B), but are susceptible to bunt and leaf rust. CHINOOK produces attractive grain of high bushel weight. RESCUE is slightly more sawfly resistant than Chinook but is not eligible for grades higher than No. 3 Northern.

DURUM WHEAT

The production of DURUM (Macaroni) wheat varieties should be restricted to **southern zones** because of their late maturity. They are similar to hard red spring wheats in yield, but are generally more susceptible to lodging. MINDUM, RAMSEY, and STEWART are suitable varieties for production in Southern Alberta.

HARD RED WINTER WHEAT

KHARKOV MC 22 is the most winter hardy variety available. It is high yielding, resistant to lodging, but tends to shatter and is very susceptible to bunt. YOGO is equal to Kharkov in yield, more resistant to bunt, and to shattering, but less resistant to lodging. These varieties are suitable for production in zones 1, 2A, 2C and 3A.

SOFT WHITE SPRING WHEAT

This crop should be grown only under contract with a milling company. The most suitable varieties at present available are KENHI and LEMHI 53. Kenhi is resistant to stem rust including race 15B and moderately resistant to leaf rust. Lemhi 53 is moderately resistant to most races of stem rust (except 15B), and susceptible to leaf rust. Both are late maturing varieties.

Barley

OLLI, eligible for C.W. Grades, is the variety preferred by the domestic malting trade. It is a very early maturing, rough-awned, low yielding variety susceptible to lodging and shattering. It has considerable resistance to loose smut but is susceptible to leaf diseases.

GATEWAY, eligible for C.W. Grades, is smooth-awned, higher yielding and slightly later maturing than Olli. It is more resistant to lodging and shattering but is susceptible to loose smut and leaf diseases.

PARKLAND, eligible for C.W. Grades, is considerably higher yielding, but much later maturing than Olli. It is smooth-awned and moderately resistant to lodging and shattering. Parkland is resistant to stem rust, moderately susceptible to loose smut, and susceptible to leaf diseases.

COMPANA, eligible for C.W. 2-row Grades, is an early, two-rowed, semi-smooth-awned variety that yields well in dry areas and is suitable for straight combining. Under moist conditions it lodges badly. Compana is susceptible to stem rust, loose smut and leaf diseases.

HARLAN, not eligible for C.W. Grades, is a rough-awned, lodging resistant variety that yields well on irrigated land. It is highly resistant to shattering but tends to be low in bushel weight. Harlan is resistant to many of the leaf diseases but susceptible to loose smut and stem rust.

HUSKY, not eligible for C.W. Grades, is a smooth-awned, late maturing, very high yielding variety that is resistant to lodging. It tends to shatter in southern regions but is satisfactory in this respect in those zones where it is recommended. Husky is resistant to stem rust but susceptible to loose smut and leaf diseases.

VANTAGE, not eligible for C.W. Grades, is a medium late maturing, high yielding, lodging resistant, smooth-awned variety. Under many conditions, the awns on this variety are very persistent. Vantage is resistant to stem rust but susceptible to loose smut and the common leaf diseases.

WOLFE, not eligible for C.W. Grades, is a

smooth-awned variety that matures 4 or 5 days later than Olli. It is highly resistant to lodging and higher yielding than Olli in Central Alberta. Wolfe gives superior yields under irrigation. It is susceptible to rust, loose smut, and leaf diseases.

Oats

EAGLE is a high yielding variety with wide adaptability. It is semi-resistant to lodging, late maturing, and has a comparatively small kernel. Eagle is resistant to smut, moderately resistant to crown rust but susceptibel to stem rust.

VICTORY is recommended for production in northern regions only, where it is equal to Eagle in yield and maturity. It has an attractive grain and produces longer straw, less resistant to lodging than Eagle. Victory is susceptible to smut, stem, and crown rust.

ABEGWEIT, recommended in northern regions only, is similar to Victory in yield, earlier maturing, more resistant to lodging, but has a less attractive grain. It is resistant to some races of stem and crown rust, and moderately susceptible to smut.

EXETER, similar to Eagle in yield, is unusual in that it shows later maturity in the south and earlier maturity in the north (Fort Vermilion area.). It is a large seeded, tall variety with somewhat less lodging resistance than Eagle. Exeter is semi-resistant to smut, resistant to many races of stem rust, but susceptible to crown rust.

RODNEY yields slightly less and matures slightly earlier than Eagle, and is similar in lodging resistance. It has a large plump kernel that hulls readily. Rodney is resistant to smut and most races of stem and crown rust.

GARRY is slightly earlier maturing than Rodney and slightly lower yielding, but similar in lodging resistance. It is resistant to smut, stem rust, and most races of crown rust.

LARAIN is a very early maturing variety with large, plump kernels. It is resistant to lodging, but is low yielding and should be grown only where very early maturity is essential. It is susceptible to smut, and to stem and crown rust.

Flax

MARINE is early maturing, moderate yielding, and resistant to lodging, wilt, and rust.

REDWING is very early maturing, good yielding, resistant to lodging, moderately resistant to wilt, but susceptible to rust.

REDWOOD is late maturing, high yielding, moderately resistant to lodging, and resistant to wilt and rust.

ROCKET is medium late maturing, high yielding, resistant to lodging and rust, and moderately resistant to wilt.

SHEYENNE is very early maturing, moderate yielding, and resistant to lodging, rust, and wilt.

Rye

ANTELOPE, DAKOLD, PETKUS, and SANGASTE are varieties of fall rye available for use in Alberta. Antelope and Dakold are more winter hardy than Sangaste, which in turn is slightly hardier than Petkus. Sangaste and Petkus have large seeds, while Antelope and Dakold have small seeds. Petkus has outyielded all varieties in south and south central Alberta, while Sangaste has given superior yields in the Edmonton area. PROLIFIC is a suitable variety of spring rye.

Rape Seed, Mustard and Safflower

It is advisable that these crops be grown only under contract. MUSTARD and SAFFLOWER production should be restricted to the extreme southern part of the province. Two varieties of rape seed are now being used in Alberta. GOLDEN is a good yielding variety of the Argentine type which requires from 120 to 130 days from seeding to harvest. ARLO is a good yielding variety of the Polish type that will ripen some three weeks earlier than Golden.

IMPORTANT SEED FACTS

Use good seed.—Any elevator agent and most of the seed companies will accept your order for registered or certified seed. The use of good seed of recommended variety is the first step in production of good, high quality crops. Pedigree seed (registered or certified) assures the grower that he is getting the best available seed, free from impurities, and of high viability. It is recommended that all farmers use pedigree seed, at least at frequent intervals.

Germination tests—Frost and other conditions may lower the percentage of germination and also the vitality of seedlings. Even though the grain looks quite normal and healthy, the germination may be low. It is essential every year that grain intended for seeding be tested for germination. You can test at home in sand or soil. Moist blotter tests may be inaccurate because of the difficulty of keeping the blotters moist, and also because normal sprouts cannot be distinguished from abnormal ones that would not survive in the field. Elevator agents will send your sample away for laboratory testing. For an official test, required for seed

offered for sale, sample must be sent to the Plant Products Division, Canada Department of Agriculture, Edmonton. The fee for testing cereals is 75c for each sample, payable when the sample is submitted.

Seed treatment—Adequate seed treatment is an important aspect of crop production.

There are various materials for seed treatment on the market and farmers should make certain they obtain seed dressings that best suit their purpose.

The following factors should be considered:

(1) Follow the directions of the manufacturer.

(2) Treat wheat at least 24 hours, and oats and barley at least one week, prior to seeding.

(3) Wear a mask when treating seed.

NOTE—More detailed information on diseases, insects, etc., which are important to the production of grain crops may be found in other sections of the Guide. See Index.

Forage Crops

Forage crops are the basis of permanent agriculture and have a place on every farm. They prevent erosion by tying down the soil and provide one of the best known methods of weed control. They improve soil tilth by their fibre residue and legumes contribute to fertility. They provide an excellent source of livestock feed and prepare the land for grain crops to follow. Forage crops are widely adapted over Alberta and may even be profitably used on watercourses, low areas, field margins and roadsides.

HAY PASTURE & SILAGE CROPS FOR ALBERTA

How much of your land should be seeded to grass and legume crops at any one time will depend on where you farm. The map on page 44 will show the zone in which you are living. Keep in mind that the lines between the zones are not clear cut.

Zone 1—Rainfall is light, and, except on eroded soils, fertility appears to be fairly well maintained even under a grain-fallow system. Fibre can also be maintained by trash-cover farming which keeps as much straw and stubble as possible in the soil surface. Implements that will maintain a trash cover are essential for farming in this zone.

Regular rotations of grain and forage are rarely followed in Zone 1. With the low rainfall, soil fertility declines slowly and it is often difficult to establish forage stands. Forage crops do, however, have a place in this area. They contribute to a more balanced type of farming, prevent soil erosion and improve soil structure. A portion of the cultivated land might well be sown to grass periodically and left down for about five years. Crested wheatgrass is widely used, particularly for reseeding abandoned wheat land, regrassing overgrazed ranges and for permanent seeding down of light soils that tend to drift readily. The grazing capacity of a good stand of crested wheatgrass is considerably greater than that of native range. Russian wild rye provides a useful summer pasture in rotation with crested wheatgrass.

Sweet clover is also useful in this zone since it adds nitrogen to the soil. It should be seeded with the last grain crop before summerfallow. Where local moisture and soil conditions are suitable alfalfa is a more useful crop than sweet clover.

Zone 2—Moisture conditions in this zone mean more rapid soil depletion and a greater need for forage crops. Crested wheatgrass, Russian wild rye and sweet clover will be the choice in the drier sections. In districts of more plentiful moisture, alfalfa, brome grass, creeping red fescue, intermediate wheatgrass, and timothy may be grown to advantage. Throughout this zone, greater use should be made of sweet clover and alfalfa to improve soil fertility.

Where forage crops are included in a grain grasss rotation they should remain down from three to five years. If a satisfactory stand is established in the first year, three years of forage may be sufficient.

Irrigated Areas—Irrigation makes possible the use of a wide range of forage crops in southern Alberta.

Much of the economy of irrigated areas lies in the production of cash crops, which are best grown in a rotation system with forage crops playing the most prominent role. Alfalfa is the key to permanent agriculture in the irrigated areas. It provides the main feed source for livestock, and at the same time acts as the best soil conditioner for other crops. Sweet clover, the only other legume grown extensively, is confined to short rotations mainly in conjunction with the sugar beet industry.

There has been a marked increase in interest in irrigated pastures, and now, as well as for dairy cattle, pastures are being used extensively for beef and mutton production.

Alfalfa is the main hay crop on irrigated land, but brome, creeping red fescue, timothy, orchard grass and the clovers, all thrive under irrigation. Irrigated pastures now provide one of the main income sources in this area.

Zone 3—Alfalfa and bromegrass are the most useful forage crops, but all winter hardy grasses and legumes can be grown successfully. Altaswede (red) clover, alsike clover, timothy, and creeping red fescue are suitable in the moister parts of the zone.

Zone 4—In this zone—the grey wooded—land that is more than two to four years away from forage should not be seeded to grain. Legumes must be grown if the land is to yield profitably. Since, under natural conditions, the soil contains very little fibre, grasses are essential too. Alfalfa and the clovers, brome, timothy and creeping red fescue are all important forage crops in this area.

Forage should remain down from two to three years, depending on the kind of mixture used and the condition of the crop.

In the improvement of gray wooded soils, legumes and fertilizers should be used together. Forage crops in this zone are often more than doubled by fertilizer application. Yields of grain following fertilized legumes usually show remarkable increases.

Sulphur, nitrogen and phosphate are the main elements usually lacking. Nitrogen can be supplied by growing legume crops but sulphur and phosphate must be supplied in the form of commercial fertilizer.

Fort Vermilion Area—Rainfall is light but variable, and a tendency towards dry conditions in the early spring exists. The growing season is short restricting forage species to the more hardy varieties of alfalfa, bromegrass, crested wheatgrass and creeping red fescue. Clovers are not dependably winter hardy. A deficiency of soil nitrogen makes alfalfa an essential part of any forage mixture. Nitrogen fertilizer can be applied to advantage on two year old or older forage stands.

SEEDING PRACTICES

CHOICE OF CROP

Recommendations regarding the choice and use of forage crops are based on extensive trials conducted continuously throughout the province and should be consulted when making new seedings. Superior varieties replace the old and seed is increased under contract to ensure adequate supplies. In addition to recommended varieties it is important to use graded seed of high quality. Low grade seed may have poor germination, produce weak seedlings and be a source of weed contamination.

SEED BED PREPARATION

A firm clean seed bed is essential. In areas where soil drifting is a problem some form of protection must be provided for the seedlings. This is best accomplished by seeding into clean undisturbed grain stubble. Where stubble is not available a light seeding of oats will provide protection (see Companion Crops). In other areas clean fallow land is suitable.

COMPANION CROPS

In general, companion crops are not recommended as they provide too much competition to the forage seedling. Under drifting or eroding conditions companion crops hold the soil until the forage crop is established. Where used, the recommended crop is oats at one-half the usual rate seeded in a separate operation from the forage crop. The oats should be cut and removed as green feed.

INOCULATION

All legumes should be inoculated when seeded, especially on new land. Recommended inoculants are available from seed houses.

TIME TO SEED

(a) Spring Seeding—In Zones 1 and 2 forage seeding should be early to take full advantage of spring moisture. Throughout Zones 3 and 4 spring seeding of forage is most successful, but should not be considered later than mid-June.

(b) Early Fall Seeding—In Zone 1 and the southern half of Zones 2 and 3 early fall seeding is particularly suitable for all forage crops except sweet clover. It is hazardous during severe grasshopper outbreaks and should not extend beyond September 15th. Where used in Central Alberta, early fall seeding should be completed by August 15.

(c) Late Fall Seeding—(Just before freeze-up) is useful for placing seed in the soil for spring germination. This method is mostly used for seeding crested wheatgrass in the drier areas and for seeding reed canary grass areas subject to spring flooding.

SEEDING

Forage seeders are not essential. The grain drill is satisfactory and special adaptations are available to improve its use. One of the most useful is the flange for the discs to prevent seeding too deep. The main drill box can be used if a filler, such as cracked wheat, is mixed with the seed to maintain constant flow. Broadcasting should only be done where it is impossible to use the drill.

FERTILIZATION OF FORAGE CROPS

The section "Soil Zones and Fertilizer Recommendations" (pages 15 and 16) gives kinds and rates of fertilizer but here are some general principles:

Phosphate is needed on almost all Alberta soils, except for dry land farming in the brown zone. Phosphate is generally more important for legumes than for grasses. A phosphate fertilizer (11-48-0 or 16-20-0) frequently will maintain the legume in a grass-legume mixture.

Nitrogen—Grasses in general are more responsive to nitrogen than to phosphate although the need for some phosphate is clearly indicated. One of the most suitable fertilizers for grasses is 27-14-0.

A fertilizer supplying only nitrogen, or a high percentage of nitrogen to phosphate (e.g. 27-14-0) to a grass-legume mixture, makes it difficult for the legume to compete with the grass. Irrigation pastures require fairly heavy fertilizer application. With proper selection of nitrogen and phosphate it is possible to maintain the balance of legume and grass.

In grey soil areas where sulphur is deficient, sulphur fertilizer should be used on all grain crops. This practice increases legume hay yields and legume residues rich in protein. Nitrogen, released by decomposition of these

residues, improves grain yields for two or three years following breaking of the legume stand.

Where grasses are grown for seed, high rates of nitrogen fertilizers are recommended. They are applied, preferably, soon after harvesting the grass seed. Such fertilization offsets the tendency for grass stands to become sod-bound and encourages early formation of those plant parts necessary for seed production.

For legume seed production on sulphur-deficient soils, sulphur fertilizer should be applied at moderate rates to avoid excessive vegetative growth.

Phosphate promotes flowering and seed development and its inclusion in fertilizers used for forage seed production is generally recommended.

While barnyard manure is a useful fertilizer it can be a source of weed contamination, particularly in a forage seed crop. (See section on fertilizers.)

NATIVE HAY AND PASTURE LAND

Native grasslands in Alberta vary with soil and climatic conditions. They are classified as:

(1) Tall or fescue grassland.
(2) Mixed.
(3) Short.

The Fescue Grassland includes the black soil zone and parkland areas of southwestern and central Alberta. It also occurs in the Cypress Hills of southeastern Alberta. In fescue grassland rough fescue is dominant with porcupine grass, wheatgrasses, oatgrasses, and June grass also occurring. In the Porcupine Hills, Parry's oatgrass and Idaho fescue form an important part of the cover. Forbs and shrubs are common and may become serious range weeds under heavy use. The more important include shrubby cinquefoil, western snowberry, and rose. Cultivated forage crops that do well throughout the zone include creeping red fescue and alfalfa for pasture and brome and alfalfa for hay. Timothy and alfalfa is a high producer for one or two years but drops off badly after that time. The importance of alfalfa cannot be over-emphasized, tests to date showing yield increases of from 20 per cent to 100 per cent by adding this legume. Alfalfa is particularly important in drier years.

The fescue grassland is well supplied with stock water through springs and creeks. A major problem, because of the steeply rolling nature of much of the zone, is uniform distribution of grazing animals. Salting away from water will help. Poplar and willow growth provides stock shelter.

The Mixed Prairie and Short Grass Plains is the treeless prairie of the brown and dark brown soil zones of Alberta. A portion in extreme southeastern Alberta is often referred to as the "Short Grass Plains" but differs from the remainder only in the relative abundance of individual species. The main grasses are blue grama grass (dominant in the "Short Grass Plains"), spear grass, June grass, western wheatgrass, and porcupine grass. Common forbs include fringed sage, broomweed, crocus, and silver sage, while rose and hoary sage are the more important shrubs. When constantly overgrazed, blue grama grass and fringed sage dominate with an understory of club moss. Suitable forage crops include crested wheatgrass, Russian wild rye grass, and, in the northern portion of the zone, brome grass. Where possible, Rambler alfalfa should be included when seeding a cultivated grass for either pasture or hay.

The Provincial Department of Lands assesses lease lands on their ability to produce beef. Consequently the province is partitioned into zones in which the grazing rates range from 24 acres per head per year to 60 acres per head per year.

In general this is divided into equal acreage for summer grazing and winter feed. These rates are calculated to maintain an excellent vegetative cover under normal climatic conditions for the zone.

During the past ten years, moisture in most of the zones has been above average and based on the above rates forage has been under-used. At Stavely the best rate of grazing on good range for the period 1950-57 has been between 9 and 10 acres per head for 6 months.

While these established rates are general for the zone, the rate of grazing on the individual range is governed by the vegetative cover and the annual production.

The most common rule for grazing is to "Use half—leave half." Fifty per cent carryover allows for cover improvement and production increase.

Management of Native Range

If ranges are heavily grazed, the palatable plants are killed, and replaced by weedy, unpalatable, non-productive species that provide ideal breeding grounds for destructive insects. Over-grazed range land is subject to water erosion. It does not retain enough cover to catch and hold snow and favors loss through run-off of summer rains.

Uniform grazing is often difficult since the natural tendency of cattle is to feed along coulee bottoms and around water holes. Water holes placed from 1 to 1½ miles apart will keep livestock scattered. Salt licks away from the watering places, and scattered shelters in treeless areas also encourage best range use.

Salt licks should be moved at intervals to prevent localized abuse of the vegetation. Knowledge of the range and of livestock habits can do much to secure uniform distribution.

The management of native hayland is a problem only in areas of good moisture. On the dry plains, haying is confined to depressions and other favorable locations and can be practised anytime the growth warrants. In the foothills, Cypress Hills, and similar areas, the general practice is to cut upland hay only in alternate years. Cutting more often results in damage to rough fescue, particularly, with a consequent drop-off in yield of hay.

In the tall grassland, the most productive hay crops are brome, timothy, or intermediate wheatgrass mixed with alfalfa.

In the mixed grass area, brome, crested, or intermediate wheatgrass with alfalfa in the more moist areas, and crested wheatgrass with Rambler alfalfa in dry parts provide best hay yields.

Management of Cultivated Pastures

1. Mixtures of grasses and legumes are suggested because:
   a. carrying capacity is increased;
   b. legumes in the mixture prevent grass stands from becoming sod-bound (nitrogen deficient) so quickly.

2. Five or six years is usually the productive limit of most seeded pastures. Older stands should be plowed up and the land used for other crops.

3. When production declines, the pasture can be worked with implements like the disc harrow, one-way or cultivator, but reseeding and fertilization must accompany this surface cultivation for lasting benefit.

4. Pasture plantings can be grazed late the first year if they are not overgrazed or animals left on wet fields to cause damage by trampling.

5. Grazing of established stands should not begin in the spring until growth is 8-10 inches high and should cease when the pasture has been grazed down to three inches. Growth above three inches should then be clipped, and put up as silage or hay or left on the field.

6. Controlled rotational grazing is more profitable than any other single pasture practice. Alternate grazing of two or three fields provides the plants with periods of rest and recovery. Avoid overgrazing at all times, particularly in the early spring and fall.

7. Pastures should be harrowed to spread droppings and applied barnyard manure.

8. Any succulent forage may cause bloat in sheep and cattle. Young legumes are especially troublesome, with alfalfa usually the worst offender. Alfalfa is very palatable, grows quickly and tall, and remains succulent (nature) up to blooming. Even in a mixture with grass, livestock will readily sort it out and may get too much. In spite of this, legumes, including alfalfa, should be widely used in pasture mixtures. Where proper management is practised, losses from bloat are rare.

9. On irrigated pastures rotational grazing is essential. Maximum production is obtained by the quick removal of top growth and allowing at least 3 weeks for recovery before regrazing. Rotational grazing with a minimum of four fields is recommended. Fields should be of a size that can be grazed off in approximately 7 days. Following each grazing the field should be cut with a mower to remove excess growth, harrowed to break up droppings, and irrigated. Excess pasture in the spring should be harvested for hay or silage.

Control of Bloat

(See Section on Livestock Diseases)

1. While legumes are important in pasture, it may be desirable for bloat prevention to reduce the proportion of legume under certain conditions. This can be done with 2.4.D for alfalfa or brush-kill for white clover.

2. Make dry roughage available to stock on pasture by hauling straw, or by cutting and windrowing the forage throughout the pastures before turning in the stock.

Annual Pasture

Annual pasture crops are useful for supplementing perennial pastures and for intensively grazed areas such as paddocks, hog pastures and poultry runs.

1. Oats, or oats and fall rye in mixture, are favoured for annual pasture. These crops should be sown in late May or early June so as to have them in the boot stage and ready to pasture by late July when other pastures are past their best.

2. Cover crops, originally used to prevent soil drifting in southern Alberta, are now grown extensively for fall finishing of beef cattle in farm land adjoining the foothill areas. Oats seeded at a rate of ½ to ¾ of a bushel per acre during the last half of July is the most satisfactory cover crop. Cattle are moved in when the oats are from 12 to 15 inches high.

3. The only annual forage, other than cereals, that has proved useful and economical in Alberta is rape (not to be confused with oil seed rape). It is useful as a pasture for hogs and lambs; it grows quickly and lambs make very good gains on it. Dwarf Essex rape or Gartons Early Giant, seeded at 4 to 5 pounds per acre, will normally be ready for grazing in six to seven weeks. One objection to rape for

pasturing swine is that pigs tend to scald when running in it.

Hay Crops

Hay is the basis of livestock feeding and serves also as a cash crop on irrigated land. High quality hay is essential and quality is affected by a number of controllable factors.

QUALITY

Hay quality is generally determined by leafiness, color, palatability of the stems, and the amount of foreign material. As most of the nutritive value of the plant is contained in the leaves, leafiness is the most important single factor. Hay in which the leaves have been lost during harvesting is of relatively low quality.

A bright green color is associated with high feeding value. There is a correlation between the green color and the quantity of carotene or vitamin A in the hay.

Weeds and foreign material such as dry stems of the previous year's growth and stubble lower the feeding value.

The following management procedures are offered for the production of high quality hay.

ESTABLISHING GOOD STANDS

Good stands are the best insurance against weeds or foreign material in the hay crop. Stands seeded at the recommended rates on clean land will produce the greatest amount of stem and leaf growth, while overthick stands will become very fine stemmed and yield much less. Irrigation, fertilization and cutting practices should be complete and uniform so that the whole crop will be at the same stage of growth and maturity at the time of cutting.

MANAGEMENT

Time of cutting varies with the crop but is determined by the stage of growth. With alfalfa the best time is the 10 per cent bloom stage at which both high yields and high proteins are combined. Later cutting may result in higher yield with the decrease in protein and a natural lowering of the feeding value.

Grasses vary, but in general they should be cut between the time of heading and full bloom. Beyond the full bloom stage much of the protein content of the leaves is transferred to both the roots and the seed with a consequent decrease in the value of the hay.

Curing and Handling—Rapid curing is the key to top quality hay. Alfalfa at the time of cutting usually contains 70 to 75 per cent moisture and about 12 per cent when thoroughly air dry. It can be raked and cocked at about 48 per cent moisture, safely stacked at about 25 per cent moisture, and baled at about 20 per cent moisture. Handling when dry results in a shedding and loss of leaves so that haying operations should be carried out while the crop is still tough. Good weather conditions permit cutting and raking into windrows one day and baling the next. This will usually give top quality hay. Cutting in excess of the amount that can be raked and baled the following day means that some of the hay will lie too long in the field and will be either too bleached or too dry to handle. At the same time there is a risk of the cut crop being caught by adverse weather.

Excessive handling is the main cause of loss of leaf between cutting and marketing. Hay should be handled as little as possible and while it is still tough. First drying should be done in the windrow rather than in the swath.

Storing—Most hay is stored either in the loose stack or field baled and stacked. Loose stacked hay can go into the stack slightly more moist than the baled. While hay cocking was the practice for high quality hay, it has generally been discarded because of extra cost and time in handling.

In general the sweep rack and stack are used for rapid stacking. Baling directly from the windrow is now common practice in Alberta. Here, sufficient attention should be given to moisture content as the baling of overdry hay results in excessive loss of leaves and baling of under cured hay may result in heating and moulding.

Prompt stacking and proper capping of stacks, whether of loose or baled hay, is a safeguard against weather damage. To further retain quality, some producers use open hay sheds and plastic and canvas covers.

Artificial Dehydration—In southern Alberta artificial dehydration is limited to production of dehydrated alfalfa for high quality and high protein. The alfalfa is harvested in the prebud stage and hauled to the dehydrator where it is rapidly dried and converted into alfalfa meal. Distance from field to dehydrator is a limitation since quality of the produce and efficiency of the operation are reduced by long hauls.

FORAGE CROPS FOR SILAGE

Feeding value of silage is as good as that of hay from the same crop. Silage can be put up when hay cannot and a crop thus salvaged during wet weather. Losses in feed value of silage are usually due to incorrect methods.

SILAGE MAKING

Silage making requires the right amount of moisture for proper fermentation. The moisture content should be within the range of 60 to 70 per cent. When a crop is too dry the forage will not pack, moulds develop, and the silage spoils. If the forage is too wet it may sour

or spoil and there will be an excessive loss of nutrients through leaching. Seepage may also leave the surrounding area in a boggy condition.

Moisture can be adjusted when filling the silo by sprinkling water on crops that are too dry, or by adding dry matter to those that are too moist. The dry matter can be chopped grain or chopped hay. Uniform moisture content should be maintained throughout the silo filling period.

Crops with high sugar content make the best silage while those with a low sugar content require a preservative or conditioner. Conditioners increase the sugar content so that sufficient acids are produced to preserve the silage. Molasses at the rate of 40 to 80 pounds per ton of green forage makes a good conditioner for grass-legume silage. Ground grain (barley, wheat, corn meal) serves as a drying agent as well as a conditioner and should be used at the rate of 75 to 125 pounds per ton of grass-legume forage. Beet pulp is also recommended at the rate of 100 pounds per ton of forage.

The use of preservatives is now common, one of the most popular being sulphur dioxide gas.

TYPES OF SILOS

One reason for increased interest in silage making is the success with the trench or bunker silo. These have pretty well replaced the expensive tower silos, which require considerably more labor in filling and in using. The trench type silo can use a natural trench or one dug for the purpose. Good drainage is essential. The bunker type silo is built on level ground. Two well braced walls serve as the sides, and the ends are left open. Both these types of silos are easily filled and easily emptied. The bunker type lends itself particularly to a self-feeding hang gate.

CROPS FOR SILAGE

Grass-Legume crops alone do not make particularly good silage because they are low in sugar content. Grass plants have a somewhat higher sugar content making the combination of grass and legume better than the legume alone. Grass-legume forage should be allowed to wilt down to a moisture content somewhat less than 70 per cent. Freshly cut forage usually has a moisture content of around 80 per cent. With the right percentage of dry matter in the grass-legume mixture, it is possible, but difficult, to produce silage without conditioners, so one of the above mentioned conditioners is recommended.

The forage crops recommended for grass-legume silage are:

1. Alfalfa (particularly during poor haying weather).
2. Sweet clover.
3. Reed Canary Grass.
4. Tall Wheatgrass.
5. Any forage that cannot be successfully harvested for hay.

Corn is an excellent crop. It contains sufficient sugar to produce good silage, is high yielding and extremely palatable. It packs well in the silo to produce good silage with little waste.

Oats alone makes good silage if cut while green but approaching maturity.

Peas and Oats make a high quality silage combination.

Pea Vine Silage, a by-product of the canning industry, makes good silage, particularly when a small amount of dry hay is added to absorb excess moisture.

Beet Tops. Because of clinging dirt that may cause nutritive disorders in livestock, beet-tops require special attention.

Beet Pulp is best used as it comes from the factory in the wet stage. When dried it makes an excellent conditioner for ensilage of other crops.

Miscellaneous. Weedy crops that would otherwise be lost can sometimes be salvaged by ensiling. While the nutritive value is not improved by ensiling, coarse unpalatable plants can be made completely edible.

CULTIVATED FORAGE CROPS AND VARIETIES

Alfalfa—Eight to ten lb. per acre—Prefers moist but well drained soils. Unequalled as a forage crop.

GRIMM is a hardy variety that is satisfactory in all areas of Alberta except where bacterial wilt has been a problem. It is generally lower in yield than are Ladak and Vernal.

LADAK is reasonably winter hardy and higher in forage yield than Grimm and has some resistance to bacterial wilt.

VERNAL has considerable resistance to bacterial wilt. In irrigated areas this variety is recommended where alfalfa is to be left down for long periods.

RAMBLER is a creeping-rooted variety especially useful for pasture. It is also very drought resistant and winter hardy.

Alsike—Five to six lb. per acre—Useful where moisture is adequate; on low lands, in areas subject to flooding, and in the cooler, irrigated areas.

Red Clover—Seven to eight lb. per acre—Adapted generally to the gray wooded and black soils.

ALTASWEDE is a single-cut red clover. It is a tall-growing, late-maturing, high-yielding variety with moderate resistance to disease. Altaswede blooms approximately 12 days later than LaSalle.

LaSALLE is a double-cut red clover. It is appreciably less winter hardy than Altaswede; a factor that accounts for its lower production of forage in the central and northern parts of Alberta. Except under the most favorable conditions LaSalle in Alberta should be grown only for seed.

Sweet Clover—Eight to twelve lb. per acre—Wide adaptation. Especially useful on alkaline and clay soils. Sweet clover weevil may be a problem in some areas.

ARCTIC is the standard white blossomed sweet clover for western Canada. It was selected out of common white for its winter hardiness, medium fine stem, leafiness and high forage yield. It is a few days earlier in maturity than common white. In widely distributed tests Arctic has yielded as much or more hay than any other variety in test during the last twenty years.

CUMINO is a new variety very much like Arctic except that it is relatively coumarin-free. Coumarin in ordinary sweet clover is responsible directly for "melilot taint" and indirectly for losses of livestock from "sweet clover disease." This new variety has about the same winter hardiness as the varieties Arctic and Erector. Due to the protection from "sweet clover disease" and the elimination of "melilot taint" it is probable that this variety will replace Arctic and Erector for hay, silage and pasture.

ERECTOR is a variety selected from common yellow at the Experimental Farm, Brandon, Manitoba. It is much more uniform and somewhat more upright than common yellow. It flowers a few days earlier than Arctic. At a number of Experimental Stations and Farms on the Prairie, Erector has been higher yielding than Arctic.

Brome—Ten to twelve lb. per acre—Adapted to a wide range of soil and moisture. Requires good drainage. Makes good growth throughout the summer. It is the most commonly used grass in Alberta. It is creeping rooted, long lived, but not as drought resistant as crested wheatgrass.

Creeping Red Fescue—Four to eight lb. per acre—A useful grass except where moisture is limited. Good pasture from spring to late fall, and even used for winter grazing. The best cultivated pasture grass in the foothills. Extensive root system.

OLDS CREEPING RED FESCUE is a perennial turf grass with a dense, fibrous, creeping root system, but it is not as difficult to eradicate as are some other grasses with creeping roots. It forms a dense turf that stands severe trampling without injury. The leaves are narrow, folded and have a dark green color, which is retained into the winter.

DURATURF—Same as Olds.

Crested Wheatgrass—Six to ten lbs. per acre—Thrives on the dry, open plains, and on sandy soils in other areas. Makes early spring and late fall growth. Extensive root system. It is one of the best pasture grasses for the drier areas of Western Canada and has performed well as pasture and as hay in the parkbelt region.

FAIRWAY is a shorter growing, finer stemmed and more leafy form than either Nordan or Summit. The Fairway variety predominates in the seed trade of crested wheatgrass in Canada and is the variety most generally grown at present. Fairway is a relatively short grass for hay.

SUMMIT is a high yielding variety of crested wheatgrass. On the basis of extensive hay tests throughout Western Canada, Summit has yielded 10% more hay than Fairway. It grows 3 to 4 inches taller than Fairway and this height advantage is especialy noticeable in old fields. Summit has performed particularly well in alfalfa mixture and does not crowd alfalfa out of mixtures as does the Fairway variety. Limited chemical analyses indicate the feeding value of this variety to be equal to Fairway. In moist districts Summit has suffered more winter killing in old stands than has Fairway.

NORDAN is similar to Summit in appearance and general type. In yield tests across western Canada it is equal to Summit in hay and pasture production, but is higher in seed production. Nordan is the only licensed variety of crested wheatgrass in the United States and in 1958 it was licensed for sale in Canada.

Intermediate Wheatgrass—Ten to twelve lb. per acre—Excellent for seeding permanent waterways. Makes good hay and pasture.

Orchard Grass—Ten to twelve lb. per acre—An excellent grass under irrigation, and the basis of permanent pasture mixtures in irrigated areas. May winter kill farther north.

Reed Canary Grass—Six to eight lb. per

acre—Very tolerant of flooding. Good pasture, coarse hay. Develops a tough sod. Some tolerance to alkali.

Slender Wheatgrass—Ten to twelve lb. per acre—Useful for alkali and spring flooded land. Fair hay and pasture. Stands are short lived.

Tall Wheatgrass—Ten to twelve lb. per acre —Useful for wet, alkali soils. Makes fair hay or pasture.

Timothy—Five to six lb. per acre—Likes rich, moist soils and cool temperatures. Stands are short lived.

CLIMAX is a tall, upright, relatively fine stemmed variety. It is quite leafy, with the leaves carried high on the stems. This variety is approximately seven days later maturing than common timothy. It has considerable resistance to leaf-spot and timothy rust. Hay and pasture yields have averaged between 10% and 15% higher than those of common timothy and the hay is generally of superior quality, due to the leafiness of the variety. The aftermath growth in some localities has been exceptional, a desirable characteristic from the standpoint of pasture production.

SUMMARY

CROP	SUITABLE LOCATION OR AREAS	SEEDING DEPTH AND RATE PER ACRE	SPECIAL WEED PROBLEMS	SPECIAL FACTORS	HARVESTING
BROME GRASS	Areas of moderate to ample rainfall. Should be couchgrass free.	Solid 6-8 lb., ½" to 1½" deep. Rows not recommended.	1. Couch grass 2. Stinkweed 3. Slender wheatgrass 4. Wild oats	Becomes sod bound. Use only certified couch-free seed. Check stored seed for heating.	Straight combine or swath and combine or bind and thresh. Ready to harvest when heads and upper stems dark brown and seeds strip off easily by hand.
CRESTED WHEAT-GRASS	Throughout Alberta. Avoid areas infested with weeds which cannot be controlled by spraying.	6-10 lb. solid; 5-6 lb. — 12"-14" rows. Firm moist seed bed not deeper than ½".	As in Brome	Shatters easily. Use lifting guards for row planting.	Bind or swath when heads are mostly brown with slight greenish color. Straight combine or swath and combine.
MERION BLUE GRASS AND CREEPING RED FESCUE	Areas of higher rainfall. Peace River; Olds; irrigated areas; Foothills.	2-4 lb. solid to 12" spacing. Firm moist seed bed not deeper than ½".	Couch and other grasses. Yellow Avens; dandelion; wild barley; cinquefoil.	Not reliable seed yielder in all areas. Check stored seed for heating.	Draw several heads through the hands. If loose seeds, swath and combine, or straight combine. Special cleaning equipment required for Merion Blue Grass.
TIMOTHY	Black soils area; requires abundant moisture.	3-5 lb. per acre solid. Firm moist seed bed not deeper than ½".	Small seeded false flax. Cinquefoil. Peppergrass. Shepherd's Purse. Stinkweed; Canada Thistle.	Seed shatters readily. Care must be taken not to hull the seed when threshing.	Swath and combine, or bind and thresh. Swath in late or firm dough stage. Advisable to swath when tough; evening, early morning or night time.
REED CANARY	Wide adaptation; withstands prolonged flooding. Moderate tolerance to alkali.	3-5 lb. per acre solid. 1-2 lb. per acre 24"-36" rows.	Curled Dock. Lady's Thumb. American slough grass.	Shatters very readily. Hulls easily; requires care in threshing. Check stored seed for heating.	Straight combine. Harvest when majority seeds ripe in upper half of panicle.
RUSSIAN WILD RYE	Areas of moderate rainfall. should be couch free.	Solid seeding not recommended. Rows 3' apart at 1-2 lb. per acre.	As in Brome.	A very sparse seed setter. Heavy application of nitrogen advantageous.	Bind and thresh or swath and combine. Shatters readily. Cut in soft dough stage. Seed must be dried.
ALFALFA	Grey wooded soils or irrigated areas.	Solid 4-6 lb. not over ½" deep. 4 lb. — 12" rows. Innoculate seed.	1. Sweet Clover 2. Night-flowering Catchfly 3. Ball Mustard 4. Wild Mustard 5. Russian Thistle 6. Russian Pigwood 7. Stinkweed 8. American Dragonhead	Requires wild bees for effective cross-pollination. Crop should be isolated from other legumes.	Swath and combine or bind and thresh. Harvest when majority seed pods are black.

RED CLOVER	Gray wooded, black and brown soils. Higher rainfall areas of good drainage. Irrigated areas.	Solid — 3-4 lb. not ½" deep. Inoculate. Spring pasturing will reduce seed yield.	1. Sweet Clover 2. Wild and Ball Mustard 3. Night-flowering Catchfly 4. Green Foxtail 5. Curled Dock 6. Russian Pigweed	Red, Alsike and Sweet Clover seed yields can be increased by placing one or more hives of honey bees per acre. More than one hive per acre may increase seed yield, but honey production per hive will be less.	Swath; mower with windrow attachment. Combine. Considerable seed can be saved by catching and rethreshing the straw and tailings. Harvest when majority of heads are dark brown.
ALSIKE	Gray wooded and black soils; higher rainfall areas. Withstands some flooding.	Solid — ¾ lb. not over ½" deep. Inoculate	1. Night-flowering Catchfly 2. Lamb's Quarters 3. Red Root Pigweed 4. Small Seeded weeds.		
SWEET CLOVER	Throughout Alberta. Has some tolerance to alkali.	8-10 lb., scarified seed per acre for solid seedings; not over ½" deep.	Same as alfalfa.	Hard seeds contaminate fields. Should not be grown in areas where other legumes are grown for seed.	Swath and combine.
ORCHARD GRASS	Southern Foothills range and irrigated areas.	4-6 lb. 3' rows, or thin solid stands not over ½" deep.	Same as brome.	Lacks uniformity in maturing. Harvest when most heads are ripe.	Swath solid stands row crop straight combined — watch carefully for heating.
TALL AND INTERMEDIATE WHEATGRASS	Land must be free of couch. See area of adaptation Page —.	8-10 lb. solid seeding or 6 lb. in 3' rows.	Same as brome.	Same as brome.	Straight combine does not shatter readily, may be left until ripe.

SUGGESTED MIXTURES OF GRASSES AND LEGUMES FOR PASTURE

Mixture		Adaptation
1. Ladak or Rambler alfalfa	2–3	For all but drier parts of the province.
Brome	6	
Creeping red fescue	3	
2. Ladak or Rambler alfalfa	3	Zones 3 and 2.
Brome	8	
3. Ladak or Rambler alfalfa	3	Zones 2 and 3.
Nordan or Summit crested wheatgrass	3	
Brome	6	
4. Nordan or Summit crested wheatgrass	3–5	For hay or pasture in very dry areas.
5. Brome	12	Short-term pasture under irrigation.
Ladak, Vernal or Grimm alfalfa	2	
6. Brome	7	Long-term pasture under irrigation.
Creeping red fescue	4	
Orchard grass	7	
White Dutch	2	

FOR PASTURE OR HAY

Mixture		Adaptation
1. No. 1 Pasture Mixture		For all but the drier parts of the province.
2. Ladak or Rambler alfalfa	3	For Zones 2 and 3 where moisture conditions are variable.
Brome	5	
Nordan or Summit crested wheatgrass	3	
3. Alsike	2	Suited to wet locations subject to flooding.
Reed Canary	5	
4. Alsike	2	For acid soils subject to flooding.
Red Top	5	

FOR HAY

Mixture		Adaptation
1. Ladak or Rambler alfalfa	5	Recommended for same areas as No. 1 Pasture Mixture.
Brome	6	
2. Ladak or Rambler alfalfa	5	For Zones 2 and 3.
Nordan or Summit crested wheatgrass	6	
3. Ladak or Rambler alfalfa	3	For Zones 2 and 3 where moisture conditions are variable.
Brome	5	
Nordan or Summit crested wheatgrass	3	
4. Ladak or Vernal alfalfa	5	Areas of plentiful moisture.
Climax timothy	3	
5. Altaswede red clover	5	Gray wooded or black soil areas of plentiful moisture.
Brome	6	
6. Altaswede red clover	5	Gray wooded or black soil areas of plentiful moisture.
Climax timothy	3	
7. Alsike	4	Wet locations subject to flooding.
Climax timothy	3	
8. Alsike	4	Areas subject to prolonged flooding.
Reed canary grass	3	
9. Ladak or Vernal alfalfa alone		Preferred hay crop in irrigated areas.

If 4 pounds of sweet clover are added to a mixture and the amount of other legumes slightly reduced, the forage yield will be much greater in the year after seeding. Since sweet clover is a biennial, it will disappear after the second year unless allowed to reseed.

FORAGE SEED PRODUCTION

Grass and legume seed production is now an established part of the program on many farms in Alberta. The grey wooded soils, which are low in nitrogen, require legumes to build up the content of this essential plant nutrient. Hence, legume seed production fits in well with crop rotation for the grey wooded soils. Production and marketing being somewhat erratic for grass and legume seeds, the wise farmer will not depend wholly upon those seeds for his livelihood.

SEED

Like most other enterprises, forage seed marketing is becoming more competitive, and profit is increasingly more dependent upon quality. For this reason, the seed grower should start his program with the best grade of seed obtainable. Choice of variety requires careful consideration. The selection should be one that will have popular demand to ensure sales and possibly better prices. Buyers of forage seed are becoming more variety conscious and growers should be sensitive to their demands.

SEEDING

Forage seed should be produced on land relatively free from weeds.

Row seeding usually results in higher yields than broadcast or close seeding but it has some cultural disadvantages. Extra labour is required to cultivate rows, and swaths are harder to pick up. A satisfactory compromise is to plug every second drill run so as to have rows 12 to 14 inches apart. One exception to this is Russian wild rye. This grass is a poor seed setter and should be sown in rows three feet apart. (See previous section on Seeding).

POLLINATION

All legume crops grown for seed in Alberta **must be cross-pollinated by bees.**

Sweet clover and alsike are the favourite food sources of honey bees. The acreage devoted to seed production of either of these crops should depend on the number of honey bees in the area. For good pollination, there should be at least one strong hive for every acre of alsike or sweet clover. Since honey bees prefer sweet clover, alsike seed production will suffer if sweet clover is grown nearby.

Red clover is pollinated by bumble bees and honey bees. It must be isolated from sweet clover and alsike to obtain the services of honey bees and of some bumble bees and it should be grown next to the bush or prairie in which bumble bees nest. Because honey bees do not obtain nectar from red clover, beekeepers do not want to place their hives beside red clover fields without payment. If a red clover field is isolated from sweet clover and alsike, it will pay to hire the services of bees. Such payment should be based on the loss of surplus honey by the beekeeper and the gain in pounds of seed by the seed grower.

Alfalfa is pollinated by leaf-cutter bees and bumble bees. In Alberta, honey bees are of little use for alfalfa pollination. To obtain the services of bumble bees, alfalfa must be isolated from red clover, alsike, and sweet clover. These crops do not compete with alfalfa for the services of leaf-cutter bees, but there are seldom enough leaf-cutters to produce a good crop of seed by themselves.

Therefore, it is necessary to use all the bumble bees and leaf-cutter bees in the area. This can be done by growing alfalfa in as long and as narrow a strip as possible next to bush or prairie, and by isolating it from other legume seed crops. Acreages of alfalfa for seed should be small. There will seldom be enough wild bees within flying range to pollinate more than 20 acres.

A knowledge of the likes and dislikes of the different kinds of bees in Alberta makes it clear that legume seed growing must be put on a community basis. Honey bees cannot be confined to the fields beside which they are put. Red clover and alfalfa must not only be isolated from other competing crops; they must also be isolated from wild competitors like thistle and fireweed. The less bloom there is of other plants in an area, the better will be the chances of obtaining seed crops of commercial importance.

FERTILIZERS

Fertilizer use means better seed yields. (See sections on "Fertilizers").

ROGUEING

Rogueing is a must for high quality production. This means removal, by hand, of off-type plants and any weeds or other crops which may be difficult to clean out of the seed.

HARVESTING

Straight combining of forage crops is generally not recommended since forage seed usually shatters readily. If this is the method chosen, it should be done before the crop is dead ripe, and some provision made for drying the seed before storage.

Swathing and pick-up is the most common method of harvesting, although binding and threshing is equally good. For combine or thresher settings follow the instructions of the manufacturer. Some important thumb rules in threshing are:

1. Run the cylinder at the slowest speed that will remove the seeds from the heads. This will break fewer stems and leaves and make separation much easier.
2. Never overload the machine.
3. Rub-bar cylinders are usually preferred to the toothed type.
4. Repair leaks that can result in heavy losses of seed.
5. Clean the combine thoroughly before moving from one kind of crop to another. Admixtures can degrade seed.

STORING

If seed is to be stored in sacks for any length of time, some protection from mice must be provided. 50% wettable DDT powder spread around the sacks so that the mice must walk on it will provide complete and economical protection. Storage must be dry and care taken to prevent snow or rain from reaching the sacks.

CLEANING

Cleaning forage seed is difficult and requires specialized equipment. Only rough cleaning to remove excess dockage should be attempted on the farm. For final sleaning to highest possible grade, the seed can be shipped to one of the many commercial concerns operating efficient, well-equipped plants.

INSECT PESTS

Among destructive insects the two most important to the forage seed grower are the lygus bug and the sweet clover weevil. For information on the control of these and other insect pests, see Section on "Plant Diseases and Pests."

References:

Department of Agriculture, Edmonton
Circular 63—Hay and Pasture Crops for Alberta.
Publication 22—Hay and Pasture Mixtures for Alberta
Publication 100—LaSalle Red Clover Seed Production.
Publication 108—Grass Silage for Alberta.

University of Alberta, Edmonton
Circular 4—Legume Inoculation.
Bulletin 44—Cropping for Profit and Permanency.

Department of Agriculture, Ottawa
Mimeograph—Growing Crested Wheatgrass for Seed Production.
Publication 557—Crested Wheatgrass for Hay and Pasture.
Publication 693—Improved Pasture Crops and Pasture Practices for Central Alberta.
Publication 735—Alfalfa for Hay, Silage and Pasture.
Publication 753—Hay Making With Crested Wheatgrass in the Dry Areas of Alberta.
Publication 860—Annual Crops for Hay and Pasture.
Publication 866—Brome Grass Seed Production in Western Canada.
Publication 894—Red Clover for Hay, Silage, Pasture and Seed.
Publication 980—Pasture and Hay Crops for the Southern Canadian Prairies.
Publication 984— Alfalfa Seed Production in the Prairie Provinces.
Publication 998—Sweet Clover in Western Canada.
Publication 991—Russian Wild Rye Grass.
Publication 1030—Rambler Alfalfa.

Horticulture

CARE OF TREES AND SHRUBS

Planting Suggestions—It is important to obtain the best nursery stock recommended for your particular horticultural zone (see "Alberta Horticultural Guide"). Vigorous, well matured planting material will withstand transplanting better and is more resistant to pests and diseases. Autumn-planted trees are subject to winter injury, so in Alberta spring planting is preferred for most trees and shrubs. If trees are planted during the fall they should be well watered until freeze-up. Large planting areas should be summerfallowed or planted with a row crop at least one year prior to planting. Deep plowing in October and leaving the soil rough over the winter is beneficial especially with heavy clay soils. Lay out and stake the planting area before digging planting holes.

Planting Holes—When digging holes, it is recommended that the top-soil be kept separate from the subsoil. Size of hole depends upon the age of the tree and root development but should be large enough to receive the roots without bending. The moisture holding capacity of the soil can be improved by mixing organic matter with the top-soil.

Care of Nursery Stock Before Planting—On receipt of planting material the packages should be opened and moistened at once and heeled-in or transplanted. Avoid unnecessary exposure to wind and sun. When nursery stock is received in autumn for spring planting, special care must be taken for winter protection.

Setting the Trees—Trim any broken or ragged roots with a sharp knife or pruning shears. Set the roots to stand in their normal position. Plant the trees about two inches deeper than than they stood in the nursery row. Trees are usually slightly inclined towards the prevailing wind. Use top-soil as much as possible for back-filling the holes. The soil should be packed firmly around the roots, layer by layer. A depression of approximately one inch must be left for watering. Failure is usually due to insufficient compacting of the soil in planting. Water newly planted trees well. To avoid excess evaporation, keep the top-soil loose and possibly provide a mulch.

Feeding—Newly planted trees should be fertilized in the spring with 2 lbs. fertilizer per tree. Recommended are 6-10-4, 4-10-8 or 5-10-5. Maintain shallow cultivation of the planted area for the first 3-4 years. Established trees (five years and older) are supplied with 1½ to 2 lbs. of fertilizer per inch of tree diameter measured at three feet above the ground. For established trees punch holes 15 inches deep (1½ inch diameter) and 18 inches apart in two concentric circles of which the outer circle is the circumference of the crown projected on the ground.

Pests and Diseases—See section on "Field Crops—Plant diseases and Pests," page 85.

PRUNING

Deciduous Trees—Pruning is an art in itself and is often overpractised. Trees in spacious surroundings require the minimum of pruning and it is only justified to remove dead and injured wood, to prevent weak and narrow crotches, to distribute the number of main branches on the trunk and to remove crossing and interfering branches. The best season for pruning is early spring.

When pruning, cut the branches close to their origin. Do not leave stubs; they do not heal readily and are subject to infection. Large limbs should be pruned by means of a double cut, started with a cut on the lower side of the branch at a distance of 10 inches from the trunk and another immediately above, slightly closer to the trunk. After the branch has been removed, the stub can be sawn off close to the trunk.

Shrubs—Most shrubs are pruned early in the spring before the buds break, but spring flowering shrubs, such as lilac are pruned immediately after flowering. In many cases, remove only unwanted branches at the base. Heading-back of branches is only recommended when dealing with formal shapes, such as hedges, where the natural shape of a shrub is not preserved.

Evergreens—Evergreens are slow growers and pruning should be done with extreme care. Mugho pines must be pruned each year to maintain their dwarfing habit. The terminal spring growth should be headed back by two-thirds, before the buds open. No additional pruning should be attempted. Fir and spruce can be handled in a similar way. Do not remove lower branches of spruce, pine and fir.

Apple—On planting a one-year old apple tree, the whip should be headed-back to a height of 15 inches with a terminal on the windward side. The main trunk of a well-established second-year old tree is again cut back leaving a terminal bud on the leeward side. The future scaffold limbs must be headed back to promote spreading. The location of the new terminal bud will determine the direc-

tion of the new shoot. During the second year the leeward side bud will develop into a new leader whereas the next lower bud will yield shoot which is growing away from the main stem. Pruning of a three-year-old tree consists of heading back the new leader and the lower shoot. Side branches are cut back and those with narrow crotches are removed. Crotches are considered narrow when the angle is less than 45°. During later years a main leader developing in the windward direction is of importance together with 6 to 8 vigorous branches 6 to 12 inches apart and well distributed around the trunk. Heavy pruning will delay fruit bearing, hence, later pruning has to be carried out very carefully, improving particularly the secondary framework of the tree.

Plum—Pruning should be light. The main leader should not be headed-back within the first three years. Existing side branches of two-year-old trees are to be developed as scaffolds and are headed-back to approximately 15 inches.

Sour Cherry—On planting, the trees are headed-back to 24 inches. Four to five thrifty, well placed branches will make a good framework with the lowest branch facing the southwest. Yearly pruning is needed for good fruit setting.

Sand Cherry—This type of cherry fruits on one-year old wood and hence, pruning is necessary to promote shoot development. Two- and three-year wood should be headed-back severely every year.

Wound Dressing—Treat wounds over 2 inches with Bordeaux paste, made from linseed oil and Bordeaux powder or trade asphalt compounds. Apply paste to the cut area without spreading over the adjoining bark.

SHELTERBELTS

General Information

1. Summerfallow one year prior to planting.
2. Fence to protect against livestock.
3. Guard against fire damage.
4. Maintain clean cultivation both inside and outside of shelterbelt.

References:
Department of Agriculture, Edmonton
Guide to Successful Tree Planting.
Publication 92—Alberta Horticultural Guide.

5. Never plant evergreens in same row as broadleaf trees.
6. Never prune shelterbelt trees except to remove dead or broken branches.
7. Always prepare a definite and complete plan of the tree planting program before the work is started.

Farmstead Shelterbelts—An ideal farm shelterbelt is made up of a snow trap of low-growing hedge material in the first row, fast growing deciduous trees in the second, slow growing deciduous trees in the third, and evergreens in the fourth. Two or more rows of each may be used if desired. Rows should be spaced wide enough so that farm power cultivators may be used. There should be 100 feet between buildings and shelterbelts.

As hedge material caragana, lilac, honeysuckle, buffalo berry, native fruits, sea buckthorn, hawthorn, dogwood and flowering currant (Potter strain). In low and wet locations, laurel willows should be planted.

Some fast growing, short-lived trees are male poplars, laurel leafed willows, Manitoba maple (not for Peace River or Foothills regions), Dropmore elm, mayday. Slower growing, long-lived trees are green ash and American elm. Evergreens recommended are Colorado and white spruce, and Scotch and lodgepole pine.

FIELD AND ROADSIDE WINDBREAKS

Field windbreaks, for wind erosion control, are planted in single rows 30 to 40 rods apart.

Roadside windbreaks should be 125 feet from the fence line. They act as permanent snow fences and reduce road clearing costs.

For sources of information and to obtain shelterbelt trees, apply to Department of Agriculture, Field Crops Branch, Edmonton, Alberta, or your District Agriculturist.

SMALL FRUIT GROWING

For information on growing strawberries, gooseberries, grapes, blueberries, cranberries, raspberries (red, black and purple), currants; and saskatoons; see references.

HOME VEGETABLE GROWING

General—Choose a level area not subject to late frosts. Half of the area should be summerfallowed the year previous to planting and supplied with twelve to fifteen tons of well-rotted manure to the acre.

The Soil—Very light or heavy soils are to be avoided whenever possible. They may be modified by good garden practices, e.g. by plowing under granulated peat, well-rotted manure or green manure crops such as oats, rye or sweet clover.

Fertilizers—Fertility is maintained by the addition of well-rotted manures, vegetable refuse and straw (free of weeds), commercial fertilizers, and by conserving the fertility already present in the soil. For most Alberta gardens additional phosphorus should be added to supplement the small amounts that are present in animal manures. Superphosphate at 200-300 pounds per acre every two years should be ample, while a fertilizer such as ammonium phosphate 11-48-0 may replace the manure and superphosphate applications when

applied at 100 to 200 pounds per acre every two years.

Crop succession—The length of growing season, the space required by mature plants, the location of the perennial vegetable beds, the possibility of using a succession of crops in any one season, all these are points to be considered in planning a garden. Rhubarb and asparagus may be completely separated from the main vegetable plot. Short season crops such as radish, lettuce, early cabbage, etc., may be grown quite close to vine crops (cucumbers, squash, etc.). Late cabbage, cauliflower and Swede turnips will require more room, and by careful planning a succession of crops such as radish, transplanted head lettuce and winter cabbage may be arranged.

Starting Plants Under Glass—Seeds are sown in plant pots or wooden boxes (flats), and the initial seedling growth may take place either in a sunny house window or in a greenhouse or hotbed. If manure is used for making the hotbed, it should be tramped in place at least two weeks before the bed is used. For seed treatment see section on plant diseases, page—

Transplanting Seedlings—When the young plants are showing their first true leaves, they are ready for transplanting to other containers, and for this purpose, flats of a standard size (about 18" x 12" x 3½') are used. The plants are set 1½ x 1½ inches or 2 x 2 inches apart depending upon the type of plant, and the amount of hotbed space available. A mixture of two parts composted soil (garden loam with well-rotted manure) to one part of sand is excellent for growing transplanted plants.

Hardening Off—When frost danger lessens, the young plants are "hardened off" by gradually reducing the moisture, and by increasing direct exposure to both day and night temperatures. When transplanted to the field, place them as deep or a little deeper than they grew in the flats, and firm the soil about the roots.

Field Seeding—Sowing seeds directly in the garden, is usual with such vegetables as peas, beans, corn, late lettuce, carrots, etc. Seeds require optimum conditions of temperature and air before they will germinate. Arrange planting time to conform to these conditions.

Cultivation—This is most necessary and begins with thorough soil preparation before the seeds are planted, to ensure a uniform consistency of the topsoil. Frequent cultivation after the garden is seeded, especially after rains and artificial watering, will control weeds.

Bulb Crops—Bulb crops include onions, leeks and garlic. Onions may be grown from seed sown early in the open ground, from plants started under glass, or from "sets" grown the previous year. The seed is drilled into rows 12 to 15 inches in the rows. Seed sown indoors in flats during late March produces plants that should be hardened off in mid-May. The plants should be root and top pruned lightly at transplanting time, and care be taken to set the plants shallow enough. Onion sets are set out in early May, usually earlier than seedlings may be transplanted. By late August or early September the onion tops should start to fall. At this time the bulbs are pulled and left in the field in windrows to dry for a week or ten days. Often protection against heavy dews and early frost must be provided.

Salad Crops and Greens—Lettuce, spinach, Swiss chard, kale and celery are the most important of these crops. Lettuce is often seeded under glass and transplanted in early May. However, for later crops, seed may be planted out of doors as soon as the land can be worked. Place the rows 15 to 20 inches apart, and thin leaf lettuce to 4 to 6 inches in the row, and head lettuce to 8 inches. Succession planting will provide a supply over several weeks.

Spinach may be harvested for only a few weeks after sowing. New Zealand spinach, a mid-summer maturing plant, is sown in early spring and the plants thinned to 12 inches apart. Pick the individual leaves as required for greens. Swiss chard should be sown in the garden in early spring, and the plants thinned to 8 to 10 inches in the row. Celery, a tender, long season crop, should be sown indoors in early March, and after a period in the hotbed and coldframe, transplanted to the garden in early June, at 6 to 8 inches apart in rows 36 inches apart.

Root Crops—Radishes are our shortest season crop, but except for the little known winter varieties, they do not keep long and grow to best advantage during the cool spring weather. All the root crops for winter storage require similar garden culture. All are seeded directly into the field, thinned to a suitable distance after germination, and kept free from weeds until harvest time.

Carrots and beets are thinned to 2 inches apart, parsnips to 3 and Swede turnips from 10 to 12 inches. Rows in general are 30 to 36 inches apart. Parsnips germinate slowly; they should be planted in early spring. For storage, plant carrots, beets, parsnips and turnips in early June. For continuous use, successive plantings of these vegetables may be made, beginning in very early spring.

Cole Crops—Most commonly grown are cabbage, cauliflower, broccoli and Brussels sprouts.

Early varieties of cabbage, cauliflower and broccoli mature satisfactorily if sown out of doors in the early spring. By starting the plants indoors, an earlier crop can be harvested. To obtain tender white cauliflower, leaves should be tied or broken over the developing head.

Peas and Beans—(Peas and beans constitute one of the most widely grown vegetable groups.) Peas will stand considerable frost, but beans are very tender and if planted before frost danger is over, may have to be replanted. A succession of maturity with both beans and peas may be secured either by successive plantings or by planting early, medium and late varieties. Peas and beans are grown from seed planted directly out of doors, and spaced 1½ to 3 inches in the row, with rows 24 inches apart.

Vine Crops—In most districts of the province, squash, pumpkins and cucumbers usually succeed when sown directly out of doors May 20 to May 25. They may be started in the greenhouse or hotbed about the first of May, and transplanted to the garden early in June. To avoid disturbing the root system, two seeds are sown in bottomless paper cups filled with soil and closely set together in a wooden flat. The paper is carefully transplanted together with the young plants. Do not set the plant too deep. Hotcaps are often used for two weeks after transplanting when the outside temperature is cool.

Allow 8 x 8 feet for each hill of three plants of vine type squash and pumpkins. Bush type squash are planted at 4 x 6 feet. Cucumbers are muskmelons are set 3 x 6 feet if in hills, or 2 x 4 feet if single plants are used.

Tomatoes, Peppers and Eggplants—Tomatoes are started indoors, later (being) transplanted and moved from hotbed to coldframe and to the garden (in early June) when frost danger is past. Pruning of indeterminate varieties consists of pinching out all side branches, leaving only the blossom clusters and leaves attached to the main stem. The single stem is loosely tied with raffia to a sturdy stake. Unpruned plants require a space of 3 x 3 feet whereas 2 x 4 feet is ample for pruned plants. Many new varieties are self-pruning.

Eggplant seedlings are planted in the field at 2 x 3 feet and peppers 1 x 3 feet. Both should be transplanted in plant bands or with a good ball of soil on the roots, (and should not be checked by over-watering.) They prefer hot, dry conditions and a rather light loam soil.

Sweet Corn—Corn is seeded in drills 6 inches apart and thinned to 12 inches, or in hills (three plants in a hill every 36 inches) and the rows 36 inches apart. Seeding should be done about mid-May, and frequent but light cultivation given the crop. Since corn plants depend upon the wind for pollination, the garden plot should be of several short rows, side by side, rather than one long row.

References:

Alberta Department of Agriculture:
Publication 137—"Potatoes in Alberta."
Publication 92—"Horticultural Guide."
Horticulture Station, Brooks

Experimental Farm, Lethbridge.
Canning and Specialty Crops.

Information Service,

Dept. of Agriculture, Ottawa.
List of publications.

University of Alberta, Edmonton.
Bull. 54—Small Fruit Growing in Alberta.

Plant Diseases

SMUTS

The smuts of cereals are caused by fungi, and the black, dusty particles seen by the farmer are, the spores or seed of these. Smuts of cereals are carried on the surface of the kernel, or established within the kernel. The first group are bunt or stinking smut of wheat, dwarf bunt of wheat, covered smut of barley, false loose smut of barley, covered smut of oats, and loose smut of oats; the second are true loose smut of barley and loose smut of wheat. The farmer must know smuts, since control methods for one group are useless for the other. All smuts on the surface of the seed may be controlled with chemicals, but these cannot kill the fungus embedded within the seed. Dwarf bunt is a special case. Its spores are seed borne and can live over in the soil. Control of dwarf bunt requires a combination of seed treatment and crop rotation.

In Alberta the loose smut of wheat is of little importance. True loose smut of barley is important and widespread throughout the province. It can be controlled only by water-soak or hot water treatment. Table —. This smut can be recognized early as the smutted heads emerge from the boot before healthy heads. Within a few days the spores dry out and are dispersed by the wind to the flowers of healthy heads. The infected kernel is normal in appearance, but only smutted heads will grow from it.

ROOT ROTS

Common Root Rot is widespread and exacts a heavy toll. Wheat and barley suffer major damage, but oats is little affected and this is important, in planning the rotation for control.

Common root rot is caused by fungi in the soil, particularly on the trash susceptible crops and on the seed. The fungi attack the seedlings in the spring and, the crop may be thinned out radically at this stage. The roots and crowns are attacked, and brown rotted areas are evidence of damage. Roots are frequently rotted through and incapable of transporting water and minerals.

The damage caused to wheat and barley is closely related to the rotation. Root rot fungi are favored by these crops and if root rot is a problem, barley or wheat should not be sown for more than two years continuously. They should be followed by crops such as oats, flax, legumes, or by fallow.

Take-all Root Rot is often serious, particularly in the black soil zone. It attacks many of the grasses and is seen on wheat or barley after breaking. The fungus appears to remain in the soil for many years. Under certain conditions of climate and cropping it may cause considerable damage.

The fungus becomes established in the plant during the seedling stage and tends to occur in patches throughout the field. In such patches the plants are short and unthrifty and many white heads will be noted. The crown and roots may all be attacked and with more extensive damage than by common root rot. The lesions caused by the latter are brown, whereas with take-all the roots and crowns are jet black. Take-all causes such complete rotting of roots that severely affected plants may be pulled easily. Even in severe common root rot the plant retains a fairly good anchorage in the soil.

Take-all is held under control if fallow or non-susceptible crops such as oats, flax, or legumes are included in the rotation.

Control of Root Rots — The most effective methods involve crop rotations and cultural practices. Seed treatment will effectively eliminate spores on the seed and in the soil immediately surrounding the seed. They will be ineffective in the soil through which the roots and crown grow. Despite only limited control it is recommended that seed be treated every year.

LEAF DISEASES OF CEREALS

Fungi, bacteria, and viruses impair or destroy leaf tissue, thus evoking specific spots, blotches, streaks, or stripes by which the disease may be recognized. If considerable leaf areas are killed, vigor is reduced and the grain becomes shrivelled and light.

Fungi and bacteria usually survive on stubble, straw, leaf fragments and seed. They multiply under favorable conditions and set up the first infections. During the growing season a fresh supply of spores and bacteria is spread by wind and rain to other plants.

Scald, a leaf disease of barley, is widespread but usually reaches epidemic proportions only in central and northern Alberta. It attacks barley from seedling to the pre-heading stage and is favored by cool, moist weather. The disease may be recognized by lens-shaped spots, which at first are water-soaked and gray green but rapidly dry to a light gray with a definite dark brown margin. As the season

progresses the diseased areas weaken and shredding of leaves occurs.

Net Blotch of barley is prevalent and becomes destructive when cool weather prevails. Brown areas may appear on leaves of the seedlings but are more prominent closer to maturity. These areas show a net work of dark brown lines within an area of lighter brown. The netted areas enlarge and fuse in the course of the season.

Bacterial Blight of barley is usually of minor importance but occasionally severe outbreaks occur. Diseased leaves develop narrow, glossy strips, which at first are water-soaked and exude small drops of sticky substance. Sometimes the heads are attacked and distorted. The disease is favored by wet weather and spread by rain and insects.

Two leaf diseases of barley of minor importance in Alberta are:

Speckled Leaf Blotch produces straw-colored lesions later dotted with black specks.

Spot Blotch produces dark brown spots. The heads are attacked and seed is discolored at its base.

Halo Blight of oats, a bacterial leaf disease, causes relatively little damage. The lesions are oval to oblong, water-soaked at first but changing gradually to buff or light brown. A light yellow halo surrounds these spots. Badly infected leaves may turn brown and die.

Wheat in central and northern Alberta is relatively free of leaf disease but in the south the winter and spring wheats often suffer from streak mosaic. Light green to yellow streaks on the leaves and often severe stunting are symptoms. Mites carry this virus from one plant to the next. Both mites and the disease virus need a continuous supply of green plants, principally wheat. Control by keeping the land free from volunteer wheat for a week or more before wheat is sown in the same or adjacent fields. Seed winter wheat in the first two weeks of September.

Fungus and bacterial leaf diseases may be combatted in four ways:

(1) Grow disease-resistant varieties. Consult the District Agriculturist for recommendations.

(2) Rotate crops and practice field sanitation. Most pathogens cause leaf diseases of a particular cereal crop only. Since the root rot fungi will attack barley and wheat, include fallow, oats, and legumes in the rotation. Infested crop residue should be removed where such measures are not contrary to good soil conservation practices. Occasional plowing buries the trash and the fungi at the same time.

(3) Treat seed. See your District Agriculturist for recommendations.

(4) Use registered or certified seed.

TRASH COVER AND PLANT DISEASES

In recent years leaf diseases and root rots appear to take an increasing toll of cereal crops. Among the factors that have contributed to this, maintaining a trash cover to prevent soil erosion appears to be the most important. The wider use of the combine harvester-thresher has aggravated the situation by increasing the amount of straw in the trash cover.

All the leaf-inhabiting fungi and bacteria survive on straw and leaf fragments. They pass the seasons between crops in a more or less dormant state. With warmer and moist weather the fungi produce spores, and bacteria multiply in great numbers. These spores and bacteria are the first infectious agents. The combine ensures distribution of infested fragments over the field. The shallow cultivation leaves the plant debris on or near the surface of the ground and provides the pathogens with excellent opportunities to infect the young seedlings.

These organisms were once kept down by burning the straw and plowing down stubble. Plant disease control must be based now on the maintenance of trash cover as good soil conservation practice. Control of leaf and root rot diseases will depend, more than ever on crop rotation. Most leaf pathogens will attack a specific crop only but root rot organisms will attack wheat and barley equally. Diseased crops of wheat may be followed by oats, non-cereal crops, and, except for root rot control, by barley. When a resistant crop is grown the organisms will decrease.

Leaf and root rot diseases are reduced by occasional plowing, and if done immediately prior to seeding, the soil will be without cover for only a few days.

RUSTS

Cereal rusts attack the stems and leaves of the grain at any time during the growth period. **Stem rust** is identified by reddish brown, elongate pustules with somewhat tattered edges which, when rubbed, give a rusty appearance to the fingers. Stem or 'black rust' is more destructive than leaf rust, but is not often found in serious proportions in Alberta. Stem rust requires barberry to complete its life cycle. Barberry is not native to Alberta; epidemics here must arise from spores that are blown in. These usually do not arrive until the crop is near maturity. Leaf rusts are

generally less serious and are what most farmers know as 'red rust'.

For control see table, page 70.

Flax Rust—See diseases of flax and table, page 73.

ERGOT

As cereals or grasses approach maturity, purple hornlike bodies protruding from the heads are ergot bodies or sclerotia. The sclerotia fall to the ground in autumn, lie dormant during the winter, and germinate to produce spores in the spring. The spores infect the plants at flowering time and within ten days sticky drops ooze from the glumes containing spores that infect other plants. This fungus can attack all of our cereals and common grasses. Thus, the grasses beside the fields constitute a potential threat to our economic plants and infected grass forage crops are a hazard to livestock since the ergot is a deadly poison. For control see table, page 71.

2,4-D INJURIES

2,4-D is a major cause of damage to field and horticultural plants. The chemical is a growth hormone and kills weeds by forcing them to excessive growth. On other plants they have similar effects. Damage to cereals is usually seen as swelling of the two lower nodes and splitting of the stem near the soil surface. Injury of leaves has been noted on trees, shrubs, ornamentals, fruits, and vegetables. Leaves may show cupping, stringiness, or brown dead areas at the edges. These deformaties and injuries are associated with abnormal veins, more prominent than in healthy leaves, and tend to run parallel rather than fan-like. The leaves are also thicker, brittle, and dark green.

The fumes from 2,4-D drift with the wind, often for considerable distances, particularly when the ester is used. Never use 2,4-D when the wind is blowing from the treated area toward the garden plot.

Diseases Of Grasses

WINTER CROWN ROT OR SNOW MOLD

Snow mold is probably the most severe disease of cultivated grasses in central and northern Alberta. The symptoms are recognized in the spring as irregular patches of dead plants, particularly noticeable on turf or pasture grass. Excessive cold injury usually causes a general killing in an area rather than localized patches. In some seasons grass stands may merely be thinned out by snow-mold fungi. Rotation with spring cereals is the best control.

SMUTS

Diseased heads appear black and produce little or no seed. Smuts may also attack the stems and leaves and appear as long or short black stripes usually on the leaf or leaf sheaths. Seed treatment is recommended for control. See page 69.

ERGOT

See table, page 71, Diseases of Cereals and Grasses and Plant Diseases.

SEEDLING BLIGHT

Seedling blight is caused by a number of soil micro-organisms, which may reduce stands by rotting of the seed or young seedlings. No recommendations for control have been made.

LEAF DISEASES

Grasses are susceptible to leaf spots, rust, mildew, and viruses. Heavy leaf infections may cause defoliation and seriously affect the production of forage. Grass varieties vary greatly in their resistance to leaf disease, e.g., Merion bluegrass is very susceptible to rust while Kentucky bluegrass is quite resistant.

CROP DISEASES — CEREALS AND GRASSES

Disease	Crop	Symptoms	Control
Bunt (covered or stinking smut)	Wheat	Bunt balls filled with black spores in place of kernels. Unbroken smut balls in threshed grain and spores from broken balls on brush ends of kernels. Unpleasant odor.	Treat with suitable fungicide. See your District Agriculturist for list. Important to give thorough coverage according to manufacturers' instructions. This has advantages beside bunt control. Avoid formalin. Use resistant varieties if suitable.
Covered smut	Barley	Heads become masses of purple black spores in thin membranes which do not rupture until threshing. Clumps of smut conspicious in threshed grain.	For covered and false loose smuts of barley, covered and loose smuts of oats same as for wheat bunt, but some fungicides not suitable. Treating week or more in advance better for some fungicides, but not all. Follow directions and see your D.A. Some resistant varieties.
False loose smut	Barley	Spikelets replaced by loose, powdery smut masses which are blown away by wind. Smutted heads resemble those caused by true loose smut except that the latter are lighter in color.	
Covered and loose smut	Oats	Dark brown spore masses replace spikelets. May be of covered or loose type or intermediate.	
Stalk smut	Rye	Dark spore masses are found in stripes on the stems and in leaves and heads. Yield of grain much reduced.	Treat as for wheat.
Head smut	Cultivated grasses	Loose type of head smut, spikelets changing to powdery black masses of spores. Plants once infected will produce smutted heads every year.	Treat seed with non mercuric fungicide such as Arasan or Captan (Orthocide) products.
Smut	Corn	Galls of various sizes, at first covered by a grey membrane, on above-ground parts.	Rotate crops. Pick galls as they appear and burn them, to reduce soil infestation.

Disease	Crop	Symptoms	Control
Loose smut	Wheat Barley	The heads become dusty masses of black spores soon blown away by winds, leaving the bare rachis. Not evident in threshed grain, lives over within healthy appearing kernels, chemicals not effective.	Use registered or certified seed. Use hot water treatment. Otherwise, for barley, treat enough for seed plot as follows: Place about 2 bus. seed in tub or barrel. Add enough, 1% salt water to keep grain covered for treatment period. Raise water and seed temperature to 70-75° F. and hold temperature for 65 hours. Drain and spread to dry quickly to prevent sprouting. Seed in plot isolated from other barley. Use crop for main planting next year.
Stem rust	Wheat Oats Barley Rye Grasses	Dusty, raised, reddish brown oblong spots on leaves, stems and heads, becoming black as the plants mature. The red spore dust may adhere to heads, clothing or machinery.	Use resistant varieties as recommended. (See Varieties of grain for Alberta—Publication No. 91.). Early seeded crops and early varieties tend to escape rust attack.
Leaf rust	Wheat Barley Rye	Dusty, yellow to light orange, small round to oval spots on leaves and sheaths, becoming black as the plant matures.	Ditto
Common root rot	Wheat Oats Barley Rye Grasses	Brown discoloration of stem bases, roots, crown, and lower leaf sheath, somewhat more distinct on barley. Reduced in height, fewer stems and grains per head. Increases in severity after successive susceptible crops.	Growing non-susceptible crops in rotation, e.g. oats, flax, legumes, rape. A two-year period without susceptible crops will eliminate much infection. Where conditions permit, the mold-board plow may be used to bury contaminated surface soil and trash, preferably just before seeding. Treat seed with mercury fungicides.
Seedling blight	Cereals	Seed rotting and death of seedlings before or shortly after they emerge, causing thin stands.	Treat seed with mercury fungicides.
Take-all root rot	Wheat Barley Grasses	Occurs in scattered plants or in patches in the black and dark brown soils. Plants stunted and bleached. White heads with no kernels. Roots shiny black and brittle. Plants easily pulled up.	After breaking native or cultivated sod use rotation wheat, oats, wheat, fallow, followed by long term rotation. Maintain soil fertility. Take-all may become troublesome if wheat follows wheat.

Disease	Crop	Symptoms	Control
Browning root rot	Wheat Oats Barley Millet Grasses	Large brown areas mainly on fallowed brown soils in June. Lower leaves extensively browned and dead. Seedlings stunted, maturity delayed and yields lowered.	Use phosphate fertilizers. Maintain soil fertility. Sow in a firm seed bed. Work in combine stubble. Grasses sown in June may be severely injured.
Ergot	Grasses Rye Barley Wheat Oats	Conspicuous hornlike purple to black fungus bodies in place of seeds; present in threshed grain. Poisonous to man and animals.	Cut all nearby grasses before they come into head. Remove ergot from seed by cleaning. If a few ergot bodies remain in the seed they are likely harmless when seeded at least two inches deep. Plow deeply to bury any sclerotia in the field. Grass hay should be cut no later than flowering time. Rotate crops. See your D.A.
Scald	Barley Rye Some grasses	Oval-or lens-shaped spots at first grey-green. Later dry to pale or white center surrounded by brown margin.	Resistant varieties, crop rotation and turning under the crop residue. Seed treatment for seed-borne inoculum.
Spot blotch	Barley Wheat Rye	Dark brown oblong to round spots that later fuse to form blotches.	Ditto
Net blotch	Barley	Brown elongate areas showing a network of darker brown lines. Netted areas enlarge and fuse.	Crop rotation, seed treatment and burying trash cover at least occasionally.
Septoria leaf and glume blotch	Wheat Barley	Light brown blotches on leaves and glumes, later speckled with tiny fruit bodies. Mature straw is dirty greyish.	Ditto
Bacterial blight	Barley	Narrow, glossy- surfaced stripes on leaves, at first water soaked, changing to dark brown and finally translucent. Affected areas give off drops of sticky bacterial substance.	Ditto
Smudge (black point)	Wheat Barley	Dark brown discoloration, especially prominent on germ end of seed.	Remove lighter seed with fanning mill. Seed treatment.

Disease	Crop	Symptoms	Control
Halo blight	Oats	Pale yellowish-green oval spots with small dead sunken centers.	Seed treatment, sanitation and rotation reduce the general abundance of the disease.
Wheat mosaic	Wheat	Light green to yellow streaks on leaves. Plants may be severely stunted.	Keep land free from disease-carrying green wheat for a week or more before wheat is sown in the same or adjacent fields.
False stripe	Barley	Chlorotic stripes turning to dark brown, mostly terminating in a V-shape.	Virus carried in seed, therefore avoid seed that is infected. Seed samples may be tested in the greenhouse where symptoms appear early at high temperatures.
Blast	Oats	White empty spikelets, usually at the base.	Cause unknown. May be unbalanced fertility.
Leaf banding	Cereal seedlings	Narrow white bands on seedling leaves or sheaths. Often break over at this point. May appear singly or in series. Caused by either high surface soil temperature or temperatures near or at freezing on consecutive nights. Control	Trash cover gives some protection.

Diseases of Flax

Disease has been a serious limiting factor in flax production and may still be if preventive measures are not taken. Brief descriptions of the more important diseases of this crop are given in Table together with suggestions for control. Rust, browning or stem break and seed rot are the most prevalent where farmers neglect control measures. Other diseases such as wilt, pasmo and yellows have proved highly destructive elsewhere and Alberta farmers should try to avoid them.

Since most flax diseases are caused by seed-borne organisms, it is wise to use seed of the highest quality from disease-free crops. Clean to remove light weight kernels, bits of stems, and other impurities, and treat with a suitable fungicide. See page 74 and section on seed treatment.

Disease resistant varieties should be sown whenever suitable and available (see section on varieties). Wilt and rust resistant varieties are obtainable and should be used though they may not remain free from other diseases.

The residues from flax crops are common sites for the over-wintering of most of the parasitic organisms. It is unwise to sow flax after flax or very close to old flax fields where the straw is still exposed. If this is done the old straw should be buried well before seeding time. Flax on fallow or after an unrelated crop such as any of the cereals, is more likely to escape disease.

Weeds may harbour certain pathogens such as the yellows virus. Hence weed control in and around flax fields may help to reduce losses from some of the diseases. Other measures of value in disease control are early seeding and the application of fertilizer where needed.

DISEASES OF FLAX

Crop	Disease	Symptoms	Control
Flax	Browning or Stem Break	Most conspicuous after flowering as brownish blotches on stems, leaves, and seed capsules. Some plants may break over just above the soil surface	Avoid sowing flax after flax and leaving stubble exposed near new flax. Use clean seed. Treat seed whether infected or clean. (See section on seed treatment).
	Rust	Small reddish powdery pustules mainly on the leaves in midsummer and smooth black blotches chiefly on the stems later in season.	Follow above measures and use a rust-immune variety if one suited to your district is available.
	Seed Rot and Seedling Blight	Poor emergence from seed decay in the soil. Some seedlings wilt and die as a result of attack by fungi.	Seed treatment with several organic fungicides. Since it is very common, all flax seed should be treated.
	Pasmo	Somewhat similar to those of browning. Develops later in season, but plants do not break over.	As for browning or stem break.
	Wilt	Plants may wilt wholly or partially at any stage. Leaves droop and tips of plants bend downwards.	Most of the newer varieties are wilt-resistant and should be grown. Avoid late seeding and continuous cropping to flax.
	Yellows	Leaves yellowish, bunched at top, and flowers greenish and deformed. Seed capsules fail to develop.	Eradication of weeds near flax fields to reduce visitation of insect carrier (a tiny leafhopper).
	Heat Canker	Plants girdled at ground line. Often fall over as seedlings or older plants.	Early and heavy seeding.

Diseases Of Forage Legumes

Disease is one of the main factors in the establishment and maintenance of a forage legume stand.

Seeding blights and the root and crown rots are caused by a combination of soil inhabiting fungi that may be widely spread or limited to a small area. The moisture and temperature requirements of the organisms are so diverse that plants may be damaged or killed both during the growing and dormant periods. Above-ground or leaf diseases often cause a reduction in vigor, resulting in lower yields of hay and (or) seed.

Bacterial wilt is one of the important diseases of alfalfa. It causes a marked reduction in forage yield and severely infected plants produce little or no viable seed.

Ideally, control of these and other forage legume diseases should consist of growing the proper disease resistant variety for the area concerned. Unfortunately, up to the present time this has been achieved satisfactorily only with bacterial wilt of alfalfa. In other cases helpful control must be sought through suitable crop rotation, crop sanitation, and other sound agronomic practices. (See page 76.)

Crop	Disease	Symptoms	Control
Alfalfa	Crown bud rot	Decay or rot of crown buds during growing season. The disease is favored by conditions that promote rapid growth.	Avoid late cutting and excessive grazing of alfalfa land. Use wise crop rotation.
	Winter crown rot	Patches of plants are killed out in early spring. The fungus can sometimes be seen covering the plants after the snow has melted.	Plant winter hardy varieties and avoid late cutting and grazing of alfalfa land.
	Winter injury	Dead plants occur singly or in patches especially under ice or in gateways under excessive trampling. Plant crowns and upper portions of roots are shredded.	Plant winter hardy varieties. Avoid excessive grazing.
	Bacterial wilt	Plants are reduced in vigor, are stunted, and may have tiny yellowished leaves. Heavily diseased plants have a brown ring in the interior of the root.	Plant a resistant variety of alfalfa sufficiently winter hardy for the area. Recommended varieties of alfalfa are given on page —.
	Black Stem	Small, black or dark brown spots on the leaves, stems, and seed pods. Heavily infected plants may drop their leaves and seed pods.	Early spring burning of stubble and crop debris before new growth begins. Make the first cutting of hay as early as possible.
	Common leaf spot	Circular brown spots on the leaves. These spots later develop raised centers. Heavily infected leaves may drop off.	Cut the hay crop early enough to catch the leaves before they fall.
	Seedling blight	Rotting of the seed, death of seedlings before or shortly after they emerge, resulting in thin stands.	Treat clean seed with non-mercurial fungicides such as Arasan, or with a captan like Orthocide. If treated seed is to be inoculated, do it just before seeding to avoid damage to the bacteria.
Alfalfa	Witches' broom	Small, yellowish leaves with dried edges borne in unusually large numbers of fine stems giving a "broom-like" appearance to the plant.	Strive to maintain healthy thick stand of alfalfa. The disease is spread by an insect that does not like shaky moist conditions.
Red clover	Northern anthracnose	Brown, sunken areas on stems, cracking of the stems, girdling of petioles and wilting of flowers, resulting in a reduced seed yield.	Crop rotation.

Crop	Disease	Symptoms	Control
Red clover	Powdery mildew	Light gray powdery growth on upper surface of the leaves. Leaves turn yellow and eventually brown where mold infection is sufficiently severe.	No economical control measures are available.
Alsike clover	Sooty blotch	Prevalent in low, wet areas. Dark brown or black blotches on the lower surface of leaves. Later in the season, infected leaves wither when the blotches are numerous.	No economical control measures are available.

Diseases of Special Crops

In recent years there has been an increase in the growing of special crops such as sunflower, safflower, sugar beets, and mustard. This increase will probably result in an increase in the prevalence of disease in these crops. The grower can take certain precautionary measures against the buildup of plant diseases, such as the use of recommended varieties, the use of disease-free seed that has been cleaned and treated, the rotation of crops, and the maintenance of good soil fertility.

Crop	Disease	Symptoms	Control
Mustard Rape	White rust	Small, raised white areas on the stems and leaves. Infected flower parts are enlarged and distorted.	Rotate crops. Use clean seed.
Mustard Rape Sugar beets	Seedling blight	Seedlings wilt and die.	A shallow, firm seed bed will result in less damage.
Mustard Rape	Downy mildew	Yellow lesions with downy mold on the leaves. Large, brown irregular-shaped growths in place of some normal seed pods.	Use well-cleaned seed.
Rape Sunflower	Wilt and basal rot	Leaves wilt, decay, and cankers form at base of the stem. Hard, black fungus bodies (sclerotia) may occur in or on diseased tissues. Heads and seeds may be affected occasionally.	Rotate with cereal and grass crops. Use clean seed.
Safflower	Rust	Red rust appears in small tufts on the leaves and stems. Infection often girdles seedlings at ground level causing plants to wilt and break off.	Rotate crops. Avoid seeding safflower adjacent to infected safflower stubble. Treat seed.
	Leaf spot	Irregular, brown spots on the lower leaves and when severe on the outer flower parts.	Rotate crops and treat seed.
	Leaf spot	Plants wilt and die.	No economical control available.
Sugar beets	Root rot	Brown to black discoloration of stem and roots of seedling.	Maintain soil fertility, rotate crops, and sow treated seed.
	Black root	Leaves have light brown spots with poorly defined margins. Speckling may occur within the spots.	Rotate crops and sow treated seed.

Crop	Disease	Symptoms	Control
Sunflower	Rust	Rust-colored spots appear on leaves and sometimes on the stems and lower surface of the head. As the plant matures the spots on the stems turn black.	Rotate crops.
	Downy mildew	Yellow spots with downy mold on the leaves. Severe stunting of plants and seeds are empty.	Rotation should not include sunflowers oftener than once in three or four years.
	Leaf mottle	The tissue between the veins of affected leaves becomes pale green, then yellow and finally die and turn brown.	Rotate crops.
	Stalk rot	Brown or black blotches that extend from the stem on to the leaf stalks.	No control.

Vegetable, Fruit Diseases

The fungi, bacteria, and viruses that cause most vegetable and fruit diseases may be carried either in or on the surface of the seed or planting stock, in the soil, in diseased tissues or in crop refuse. Weeds and other "wild" plants may also harbor some of them. Insects too are carriers. Control measures are based on these facts. See table, page—.

Plant only the best seed or stock. Resistant varieties are becoming increasingly available and should be used if recommended for your area. (see Horticultural Section).

Since several diseases are carried by seed, tubers and other propagating stock it is good strategy to start with reliable planting material. Certified, disease-free seed potatoes, raspberry canes and seeds of peas and beans are available. Some "seed-borne" diseases, such as bacterial "Halo blight" of beans, are carried within the seed and are not controlled by chemical treatments.

Seed treatment. Dusting with chemicals prior to sowing is helpful with certain seed-borne diseases as well as in providing protection from the soil organisms that cause the rotting and "damping off." Fungicides, such as Semesan, Arasan, and Spergon are widely used dusts.

For the home gardener: (1) Tear off the corner of the seed packet and add only as much chemical as can be held on the tip of a small penknife blade, (2) Fold down the corner and shake thoroughly, (3) Remove excess dust with a fine screen. For larger quantities of seed and the precautions to be taken, read the label on the container.

Care of young seedlings. Growing conditions, especially indoors, are very important. Soil for the seedling flats should not have been cropped recently with the plants to be started or with related plants. After sowing spread a thin covering of coarse sand over the surface to aid aeration, which helps to check the diseases. High humidity, extremes of temperature, excessive shading and watering should be avoided. Overwatering is probably the main reason why seedlings raised indoors suffer from damping off. Give the seedlings a thorough soaking when they require water rather than small amounts more frequently.

Protection by spraying and dusting. Once established, fruits and vegetables are exposed to various pathogens spread by wind, water, or insects. Chemicals applied as sprays or dusts are useful in protecting the plants from fungus and bacterial diseases (fungicides) and for controlling insect carriers, (insecticides).

Sprays are most effective if applied with some type of pressure sprayer. Sprays for disease prevention stick to plant surfaces better than dusts. Dusts if applied properly also are effective, and have the advantage, for home gardeners, of being "ready for use" without mixing. They often contain insecticides along with the fungicide and kill a larger variety of pests than do dusts or sprays containing only one insecticide or fungicide.

Treatments should be made when the air is still and the dust or spray forced through the foliage to both leaf surfaces. Contact with the chemical is essential.

The first application should be made as soon as the first symptoms appear or sooner if experience of previous seasons and/or the particular disease indicates this. Subsequent applications should be made as often as warranted; moist weather favors the spread of most pathogens and washes off the protective coatings.

Handle chemicals with caution; follow manufacturers directions precisely.

General Sanitation. Sprays and dusts are useful but are not cure-alls. They should go hand in hand with other sound practices designed to eradicate or reduce the sources of new infection. With virus diseases or, in the case of fruit trees, diseases affecting the woody parts, it is better to remove and destroy the whole plant or prune out the affected part rather than to wait for plant to recover. It will not. The loss of the rogued or pruned plants will be more than offset by the reduced spread to healthy plants.

General cleanliness is always helpful. During and following the growing season, prunings, trash, and after harvest refuse should be either burned or buried. It should not be used for compost. Weeds and wild fruits should be controlled since these harbor pathogens.

A rotation rather than continuous cropping will also help, especially with regard to root diseases.

Mention of a trade name does not constitute a recommendation. The name is used only as an example.

Plant	Disease	Symptoms	Control
VEGETABLES			
Beans	Halo blight	On the leaves small water-soaked spots develop into brown, dead areas of varying size and shape, often bounded by a yellow margin or halo. On the pods, brownish-red, dry, sunken lesions appear.	Do not plant discolored seeds or those from spotted pods. Use guaranteed "blight-free" seed. Avoid working around plants when foliage is wet. Burn diseased crop refuse and practise rotation.
	Anthracnose	Dark brown lesions on all above-ground parts. The most striking symptom is the formation of large, deep, dark-colored cankers on immature pods.	Follow recommendations for halo blight.
	Mosaic	Mottling (light and dark green) and puckering of leaves, stunted plants; blossoms tend to drop and pods are shorter than normal.	Grow mosaic-resistant varieties such as Contender, Tenderlong No. 15 Top-crop, Puregold Wax, Kentucky Wonder and Blue Lake.
Beets	Seed rot and damping-off	Poor seedling stand and seedling collapse.	See general statement on control of damping-off.
	Leaf spot	Numerous small spots with light tan or grey centers and dark brown borders.	Treat seed with a dust fungicide. Spray or dust with a copper fungicide only if the disease is severe. Rotate crops and clean up and burn refuse.
Cabbage and related plants	Damping off	Poor stand, seedlings collapse.	See general statement on control of damping-off.
	Black rot	Leaves turn yellow, usually in V-shaped lesions from the margins inward; blackened veins.	Use disease-free seed. Practise seedbed and field rotation.
Carrots	Yellows	Yellowing of young leaves, reddening and twisting of older leaves. Small, hairy and poor quality roots.	Damage may be reduced by controlling weeds and the leafhoppers that are carriers of this disease (see insect section).
Celery	Late blight	Small, yellow spots on older leaves and stalks turn dark grey-brown and become covered with tiny black specks.	Spray with 8-8-100 Bordeaux mixture or use a copper-lime dust at weekly intervals. Remove and destroy plant debris in fall.
Corn	Seed rot	Poor stands.	See general statement on seed treatment.

Plant	Disease	Symptoms	Control
	Smut	Large, whitish-colored, tumerous growths on stalks, ears, or tassels that burst and release a black, powdery mass of spores.	See statement in smut section of cereal disease.
Cucumber	Angular leaf spot	Small, water-soaked spots on leaves, stems, and fruits. On leaves these spots develop into tan, angular spots that are gummy or shiny on the undersurface. Spots on stems and fruits covered with a white, crusty exudate. Fruits may rot.	Destroy plant debris. Obtain seed from disease-free areas. Rotate crops.
	Bacterial wilt	Leaves and vines wilt and die. A sticky ooze is found when wilted stems are cut.	Remove and destroy wilted plants as soon as found.
Lettuce	Sclerotinia rot or drop	Progressive wilting and rotting beginning with outer leaves. Whole plant collapses and rots.	Remove and burn plants as soon as symptoms are found. Rotate with nonsusceptible crops such as corn and potatoes.
Onion	Neck rot	Rotting of stored bulbs, usually at the neck. Gray fungus growth with small, black bodies often evident.	Cure thoroughly and store at slightly above 32°F. with good ventilation. Colored varieties are more resistant than white ones.
Peas	Seed rot	Poor seedling stand.	See general statement on seed treatment.
	Leaf and pod spot	Circular or irregular tan or purplish-brown spots with darker margins on leaves, pods, and base of stems. The spots on the pods are sunken.	Remove and burn diseased vines after harvest. Use seed from disease-free areas.
	Mildew	White, fluffy, or powdery growth on leaves, stems, and pods; later dotted with dark specks.	Use a sulphur dust or spray.
	Root rots and wilt	Base of stem rotted, plants yellowish, wilted or both.	Follow a 3-4 year rotation and avoid excess moisture.
	Bacterial blight	Small, glistening, brown spots on leaves. Larger water-soaked spots on pods and stems.	Rotate with other crops. Use seed from disease-free areas.
	Leaf blotch	Indefinite areas turn pale or yellow and spread to cover the whole leaf. Numerous pin-point, black spots appear on the lower leaves and stem.	Rotation is the main control measure.

Plant	Disease	Symptoms	Control
Potato	Early blight	Small, irregularly-shaped, dark brown spots on leaves with target-like markings.	Plant certified seed. Spray with Bordeaux 10-100 or other fungicide such as Dithane at first appearance of disease and at 10-day intervals.
	Late blight	Irregular-shaped, rapidly enlarging, dark-brown areas on leaves surrounded by a water-soaked border. Infected tubers first show a purple discoloration of the skin that later develops into a brownish dry rot either in the hill or during storage.	As for early blight. Do not store diseased tubers.
	Bacterial ring rot	Yellowing, rolling, and death of leaves. Plant wilts. When cut open, tubers and stems show an internal brown ring.	Plant certified seed. When cutting seed, if the knife cuts an internally discolored tuber the blade should be disinfected before using it again and the tuber discarded. Consult your District Agriculturist.
	Leaf roll and mosiac	Mottling, rolling, and yellowing of leaves. Stunted plants.	Plant certified seed. Dig out and destroy diseased plants. Spray or dust to control insect carriers (aphids and leafhoppers).
	Scab	Rough, corky brown scabs on tubers.	Plant certified seed. Rotate with legumes or grains.
	Rhizoctonia	Brown cankerous areas at base of stems. Tops may show rolling and reddening of upper leaves and aerial tubers may form in leaf crotches. Tubers often have specks of black "dirt" that is not easily washed off.	As for scab.
	Black leg	Base of stem black and shriveled. Branches rigid and upright and leaves pale. Tubers rot starting at stem end. In storage the rot spreads, creating a vile odor.	Plant certified seed. Destroy potato refuse after harvesting. Seed pieces should be planted as soon as cut or kept in cool, well-ventilated storage. Rotate crops.
Tomato	Early and late blight	Leaf symptoms are the same as for potato. Fruit has dark, leathery decayed spots.	Spray with a fixed copper or other fungicide such as Dithane at 7-10 day intervals.
	Leaf spot	Small spots on leaves with grey-brown centers and dark margins. Dark specks in centers of spot.	Destroy vines in fall. Rotate crops.

Plant	Disease	Symptoms	Control
	Blossom-end rot	Large, sunken leathery rot occurring only at the blossom end of fruit. This condition is usually caused by the soil drying too quickly when plants are growing vigorously.	Maintain an even moisture supply
SMALL FRUITS			
Strawberry	Leaf spot	Reddish-purple spots on leaves later turn grey with a purple border.	Spray with Captan or Orthocide in the middle of May and again in early June.
	Powdery mildew	Leaves curl upwards and a white powdery growth occurs on the under surface.	Dust undersides of leaves with sulphur when the buds are unfolding and three more times at 12-day intervals.
	Yellow-edge	Central leaves dwarfed and "cupped" with yellow edges. Outer leaves more or less normal. Fruit is small.	Remove and burn all infected plants and their runners as soon as the symptom appears. Obtain virus-free stock.
	Red stele	Leaves small and bluish with short stems. Little or no fruit produced. Roots long and stringy and have a characteristic dark red core.	Destroy diseased plants and runners. Plant disease-free stock in new location.
Raspberry	Mosaic	Leaves on new canes and/or on laterals of fruiting canes are at first light green, then become mottled with yellow and tend to pucker.	Rogue out and burn diseased and adjacent plants. If extensive, destroy entire plantation. New plantation should not be within 100 yards of old location and certified virus-free stock should be used.
	Leaf curl	Leaves wrinkled, curled, and darker green than normal	As for mosaic.
	Crown gall	Plant stunted. Knobby swellings on roots.	Destroy infected plants. Plant disease-free stock in new location.
	Spur blight	Dark red or chocolate-brown spots on leaf stalks and young bark. Fruit spurs weak, chlorotic and seldom bloom.	In fall, prune out and burn all old canes and any diseased young canes. Spray with Bordeaux 3-6-40 mixture when young canes are 8-10 inches high.

Plant	Disease	Symptoms	Control
Currants Gooseberry	Powdery mildew	White, flour-like coating on young leaves and fruit, becoming light-brown and felt-like.	Spray when the leaves begin to emerge and twice more at 12-day intervals with Orthocide or wettable sulphur. Grow recommended resistant varieties.
TREE FRUITS			
Apple Crabapple Pear Mountain Ash	Fireblight	Blossoms and leafy shoots suddenly wilt, turn brown-black as if scored by fire, shrivel and die but remain on the tree. Later, cankerous areas of shrunken and discolored bark may appear on branches at the base of affected shoots.	Use resistant varieties. Diseased wood should be removed as soon as it appears, cutting about six inches below the discolored area. Wash pruning knife and cut surfaces with a solution of 1 part bichloride of mercury to 500 parts of water after each cut and burn the diseased wood.
Apple	Apple scab	Dark, green, velvety spots on leaves and fruits. On the fruit these develop into dark brown scabs.	Spray with lime-sulphur, Bordeaux mixture, or Fermate in spring and early summer. Burn leaves in fall.
Plum Cherry	Brown rot	Blossoms turn brown prematurely. Watery, brown spots enlarge and rapidly envelop the fruits and later become covered with greyish powder. Fruit dries and shrivels.	Lime sulphur, wettable sulphur, Phygon, Captan, or Fermate sprays at blossom and early fruit stage will check the spread of rot. Cut out and burn any diseased twigs. Gather and burn all rotten or mummified fruits.
Cherry Plum	Black knot	Velvety, olive green thickenings appear along the twigs in the spring and by fall develop into conspicuous black, hard, and rough-textured knots.	Cut out and burn infected wood 3-4 inches beyond the knot. Spray with lime-sulphur or other fungicide when leaf buds start to open.
Plum Cherry	Shot hole or leaf spot	Small red or brown spots on leaves. The centers of these spots drop out giving a "shot hole" effect.	Spray trees with lime-sulphur (1) in late April, (2) immediately after petals fall, and (3) 10-14 days later. Burn the fallen leaves.
	Powdery mildew	White, fluffy, or powdery growth on leaves.	Spray with lime-sulphur, wettable sulphur or Bordeaux mixture.
Plum	Plum pocket	Small, whitish spots on fruits a week or two after blossoms drop. Affected fruit becomes puffy and enlarged into bladder-like structures with a grey powdery covering.	Prune back branches severely and spray with lime-sulphur just before the buds open.

Plant	Disease		Control
Plum	Silver leaf	Branches bear leaves having a dull leaden or metallic lustre and may die the first season that silvering appears or later.	Remove and burn branches at first sign of silvering. Heavily diseased trees should be dug out and burned. Paint or shellac pruned surfaces.

Seed Treatment

Seed treatment controls certain plant diseases caused by seed-borne micro-organisms. It may also protect seed from soil-borne organisms. Consequently clean seed may benefit from it but especially seed which has been injured. Some seed treatment preparations have insecticidal as well as fungicidal value and may be useful for wireworm control.

Chemicals having germicidal properties are used mainly, though in a few instances disease control, e.g. loose smut of barley, may be effected by heat or simply by soaking the seed in salt water (see table). Different treatments may be needed for different seeds and for different diseases, but some have rather wide usefulness. The organic mercurials are usually recommended for grain. Non-mercurial organic fungicides are used extensively in vegetable seed treatment and some of them are effective for some grain diseases as well. An appraisal list of chemicals on sale in Canada for the treatment of grain crops may be obtained from district agriculturists.

In choosing a chemical select on the basis of effectiveness in disease control but also for freedom from undesirable qualities. The ideal chemical is still to be found. One should avoid formaldehyde for cereals because of its injurious effects on seed, even though it is a good fungicide. Where individuals are sensitive to certain chemicals such as the mercurials less poisonous substitutes should be sought.

TREATMENTS FOR CEREALS

Cereals are subject to numerous diseases caused by seed-borne parasites. Smut is particularly prominent and seed treatment is necessary. The so-called covered smuts or surface-borne smuts affect the cereals and can be controlled by simple chemical treatments. The true loose smuts of barley and wheat require special treatments since the fungi are inside the seed instead of on the surface. Cereals are often affected with other seed-borne fungi besides the smuts and are commonly injured in threshing. Proper seed treatment will reduce losses from these other seed-borne parasites and from certain soil-borne organisms which may rot the seed. Treatment provides a cheap and worthwhile form of crop insurance. Provided suitable materials and methods are employed it is generally safer to treat than not to treat. (See table page 69.) Special treatments such as those for loose smut and wireworm control, should be employed only when the pests are known to be present.

TREATMENTS FOR FLAX

Among the small grains none stands to benefit more from proper seed treatment than does flax. Yet much untreated flax is still sown. Flax responds to chemical treatments for seed protection from soil organisms. Treatment for this purpose alone is advisable. In addition treatment with fungicides will help to control diseases caused by seed-borne parasites. (See table page 74.) In case of flax it is necessary to avoid treatments which thoroughly wet the seed, since wet seed tends to cake. Because the seeds are smaller than cereals higher rates of chemicals are usually required to give adequate coverage.

TREATMENTS FOR MISCELLANEOUS SEEDS

Seeds of forage legumes and grasses grown in Alberta are seldom treated for disease control. While in special cases treatment may be beneficial no general recommendations for these crops have been made. The same is true for rape, mustard, sunflower and safflower. For available information on the treatment of such seeds local plant pathologists should be consulted. Treatment of certain vegetable seeds is recommended, as local tests have shown significant responses especially in improved emergence. Some of the large seeded vegetables such as garden peas and beans have shown marked responses to appropriate treatment. (See table page 79 and University of Alberta Circular 26.)

References:
University of Alberta, Edmonton
Circular 26.

Plant Pests

Insecticides

Efficient chemical control depends on knowledge of habits and seasonal development of pest insects, early recognition and identification of insect damage, and proper timing and application of insecticides.

INSECTICIDE FORMULATIONS

Insecticides are sold as prepared mixtures or formulations. Formulations are designed for specific purposes, ease of handling, and for reduction of hazards to animals and plants.

Emulsifiable concentrates are insecticides dissolved in a solvent or oil with an added emulsifying agent. These form emulsions when added to water. They do not readily settle out and can be sprayed with low-pressure equipment.

Oil solutions contain insecticides dissolved in suitable solvent mixed with oil, to be sprayed directly without further dilution. These are not to be applied to plants but are used on livestock and as space sprays.

Wettable powders are fine dust particles impregnated with insecticide with a wetting or emulsifying agent added, which permits the particles to be suspended in water. They require constant agitation and can be used only with piston or diaphragm pumps, as they cause severe wear in gear-type or impellor pumps. They should be sprayed at high pressures as they clog low pressure nozzles. Wettable powders may be used in combination with fertilizers or as seed dressings. However, specially prepared powders are more satisfactory for seed dressings.

Dusts are fine particles of an insecticide, mixed with an inert carrier such as talc. They cannot be mixed with water but must be applied with a dust applicator. Coarse forms are marketed as granular insecticides and are replacing dusts for mixing with fertilizer.

Insecticide-fertilizer mixtures are fertilizers that have been impregnated with insecticides or dry mixtures with granulated insecticides.

How to Calculate Amount Required:

Control recommendations are usually given as the weight of toxicant (actual poison) per acre. If this information is not given on the labels, it is necessary to convert the recommendation to equivalent amounts of marketed insecticide.

The labels of emulsifiable concentrates usually specify the weight of toxicant in pounds per gallon of liquid. However, the labels of some only specify the percentage concentration; thus a 50 per cent solution would contain 5 pounds of toxicant per 10 pounds of the liquid.

For easy conversion see Table I.

AMOUNTS OF FORMULATION NEEDED PER ACRE TO OBTAIN SPECIFIC AMOUNTS OF TOXICANT PER ACRE

Commercial Preparation or Formulation	Rate of toxicant recommended per acre					
	Ounces			Pounds		
	2	4	8	1	2	5
Dusts						
1%	12 1/2 lbs.	25 lbs.	50 lbs.	100 lbs.	200 lbs.	500 lbs.
2.5%	———	10 lbs.	20 lbs.	40 lbs.	80 lbs.	200 lbs.
5%	———	———	10 lbs.	20 lbs.	40 lbs.	100 lbs.
10%	———	———	———	10 lbs.	20 lbs.	50 lbs.
Wettable Powder						
15%	———	1 2/3 lbs.	3 1/3 lbs.	6 2/3 lbs.	13 1/3 lbs.	33 1/3 lbs.
25%	1/2 lb.	1 lb.	2 lbs.	4 lbs.	8 lbs.	20 lbs.
50%	1/4 lb.	1/2 lb.	1 lb.	2 lbs.	4 lbs.	10 lbs.
75%	1/6 lb.	1/3 lb.	2/3 lb.	1 1/3 lbs.	2 2/3 lbs.	6 2/3 lbs.
Emulsifiable Concentrate						
1.5 lbs. toxicant/gal.	1/3 pt.	2/3 qt.	1 1/3 qts.	2 2/3 qts.	1 1/3 gals.	3 1/3 gals.
2 lbs. toxicant/gal.	1/2 qt.	1 pt.	1 pt.	2 qts.	1 gal.	2 1/2 gals.
4 lbs. toxicant/gal.	1/4 qt.	1/2 pt.	1 pt.	1 qt.	3 1/3 gals.	1..1/4..gals.....
8 lbs. toxicant/gal.	1/8 pt.	1/4 pt.	1/2 pt.	1 pt.	1 qt.	2 1/2 qts.

The following formulas may be used where sprays are required:

1) For field crop use where recommended rate is in toxicant per acre calculate as follows:

Recommended rate per acre (wt.) x acres to be treated =

Toxicant per gallon (wt.)
gallons of emulsifiable concentrate needed.

Example—

Endrin 20 for 160 acres at 4 ounces of toxicant per acre. Endrin 20 contains 2 pounds (32 ounces) of toxicant per gallon.

$\frac{4 \times 160}{32} = 20$ gallons

At 4 gallons per acre, one gallon of Endrin 20 with 31 gallons of water will cover 8 acres at the recommended rate.

2) (a) To figure emulsifiable concentrate for a spray of a recommended percentage of toxicant.

Example—

Emulsifiable Dieldrin 20 for 100 gallons of spray containing 0.25% dieldrin. Dieldrin 20 contains 2 pounds toxicant per gallon. One gallon of water weighs 10 pounds.

Formula—

Gals. of spray needed x % toxicant required x 10 =

Pounds toxicant per gallon of emulsifiable x 100

$\frac{100 \times 0.25 \times 10}{2 \times 100} = 1.25$ gallons and fill to 100 gallons

(b) To figure wettable powder for a spray containing a recommended percentage of toxicant.

Example—

25% wettable powder malathion to make 100 gallons of spray containing 0.05% toxicant. One hundred pounds 25% wettable malathion contains 25 pounds of toxicant.

Formula—

Gals. of spray needed x % toxicant required x 10 =

% toxicant

$\frac{100 \times 0.05 \times 10}{25} = 2$ lbs. of 25% wettable powder

3) To figure if percentage of toxicant in a spray is correct.

(a) Mixture—

10 pounds of 50% wettable powder DDT mixed with 100 gallons of water.

Formula—

Lbs. wettable powder x % toxicant in formulation = Gallons of spray x 10

$\frac{10 \times 50}{100 \times 10} = 0.5$ per cent

(b) Solution—

2 gallons 25% emulsifiable DDT diluted to 100 gallon of water.

Formula—

Volume (gals.) of emulsion x lbs. of toxicant per gal = Final volume of spray mixture

$\frac{2 \times 2.5}{100} = 0.5$ per cent

25% DDT emulsion contains 2.5 pounds per gallon.

APPLICATION OF INSECTICIDES

INSECTS IN THE SOIL

Broadcast soil treatment. May be applied to the soil surface by broadcasting a dust or granular formation or by spraying. May be done on summerfallow or just before planting but shoul be followed immediately by cultivation to a depth of 3 to 4 inches. Though more expensive than other methods, this will give satisfactory control for a longer period of time.

Side Dressings — Recommended for some insects attacking row crops. Apply the insecticide in bands along one or both sides of the crop row. Liquid, dust, or granular formations, and insecticide-fertilizer combinations may be used but should be well mixed with the soil as applied.

Seed Treatments protect the germinating seed and emerging seedling. Apply to the seed coat as a dust with a sticking additive, or as a liquid. A fungicide is often included. May not reduce the insect population sufficiently in one year to protect from insect damage the following season, especially where row crops as sugar beets or potatoes follow treated grain.

INSECTS ON FOLIAGE

Spraying and dusting for insects that feed above ground spray with emulsions or wettable powders, or apply dusts. Ensure coverage on both sides of the leaves and follow all directions on the label very closely. Spraying or dusting should never be done during a strong wind. Early morning or late evening are best. If possible, spray and dust at right angles to the wind, not with or against it. This reduces drifting and danger to the operator from prolonged exposure to the insecticide.

APPLICATION EQUIPMENT

Low-volume, low-pressure sprayers may be used for emulsifiable concentrates but are **not** constructed to handle wettable powder suspensions.

With a conventional weed-spraying boom, this type is effective for broadcast applications such as liquid insecticides to the soil surface or to closely-planted cereals. It may also be used on young row crops where under-leaf spray coverage is not required. For mature row crops a special boom, such as that used on a potato sprayer, is essential to concentrate the insecticide along the row and to cover under-

sides of the leaves. When using these sprayers for insecticides, the delivery rate should be approximately 5 to 10 gallons per acre to ensure proper dispersal. A sprayer that has been used for herbicides **should not** be used for insecticides. Contamination is almost impossible to eliminate, and many valuable crops have been severely damaged by traces of weed killers.

High-pressure piston-type sprayers are more versatile and are preferred for insecticides. They are suitable for wettable powder suspensions that require high pressures to prevent clogging of nozzles and may also be used at lower pressures for broadcast or row crop application. When equipped with spray guns they are suitable for spraying livestock, barns, corrals, and shelter-belts.

Dust applicators, power driven, will apply dusts uniformly under calm conditions. The efficiency of dusting can be increased, especially on mature crops, if a canvas sheet is pulled immediately behind the dust boom The fertilizer attachment on most seed drills may be used to apply dust and granular formulations for soil insects.

Small aircraft are often more efficient and economical than other methods, especially if crops are mature and thus subject to injury by ground equipment. Aircraft sprays are fine mists. To avoid losses from drift and uneven coverage, calm conditions are essential, and should usually be undertaken only in early morning or late evening. On hot calm days aircraft sprays are subject to upward air currents, thus preventing adequate coverage.

CALIBRATING BOOM SPRAYERS

1. Measure width of boom in feet. For row crop sprayers multiply the number of rows covered by the width between the rows. (4 rows covered, 22 inches apart = 88 feet)

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2. Divide the width of the boom into 43,560 sq. ft. (1 acre). This is the distance required to cover one acre.
3. Measure off this distance or a fraction of it.
5. Spray the measured distance (3) as you operate to fill the spray system and refill the tank.
5. Spray the measured distance (3) as you would spray the field. Record speed of tractor and pressure of sprayer.
6. Carefully measure the volume of water required to refill the tank. This is the volume sprayed.
7. Convert the volume sprayed to volume per acre delivered by the sprayer at the recorded speed and pressure.
8. The volume per acre delivered (7) divided into the volume of the tank will give the acreage that will be covered by a tank-full of spray. This is the **acre-capacity** of the tank at that pressure and speed and for the type of boom used.
9. Place the amount of toxicant recommended per acre,* multiplied by acre-capacity of the tank, in a partially filled tank and fill with water.

CARE AND MAINTENANCE OF SPRAYING EQUIPMENT

Check the equipment with water before operation for leaks, clogged nozzles, etc. Breakdowns during operation require repairs to equipment that may contain extremely toxic materials. Agricultural chemicals can be very corrosive. They react with unprotected metals, rubber hose, and hose connections. Solutions of insecticide should not be left in sprayers after use. Wettable powder suspensions are very abrasive and should only be used in specially designed equipment.

All spraying equipment should be thoroughly rinsed. Spray tanks should be washed out, drained, and allowed to dry with the cover off. Pumps and hoses should be drained to prevent damage from frost. Nozzles should be removed and cleaned.

See (1) under "How to calculate the amount of insecticide required."

To lessen the danger of herbicide contamination;-

1. Fill and flush out the sprayer three times with clean water.
2. Fill the tank with a mixture of warm water and household ammonia (1 cup ammonia to 3 gallons water). Leave this in the tank for 1 to 2 days and then run it through the machine. More rapid results can be obtained if household ammonia is used with steam.

PRECAUTIONS IN HANDLING INSECTICIDES

Insecticides are poisons developed to kill insects and they can be extremely hazardous. **Humans and animals can be accidentally poisoned by swallowing the insecticide, by eating insecticide-contaminated food, or by prolonged exposure to dusts and sprays.** Continued exposure to small quantities may not cause visible symptoms but can damage the liver or other vital organs and can accumulate in the fat and milk of animals.

If blurred vision, headache, tightness of chest, or nausea are noticeable after exposure to insecticides, **call a physician at once or take the victim to a hospital immediately.** Be

certain what insecticide was used. Take the label of the container to the doctor, as the antidote is listed on it.

The following precautions should be adhered to whenever insecticides are used:-

1. **Read the label on the container.** This may save your life and prevent accident. It will name the product and its most effective use. It will also tell how to handle the material and what should be done in case of accident.
2. Wear protective clothing e.g. coveralls and rubber gloves. Epecial care should be exercised with concentrates. Respirators or dust proof masks should be worn for volatile materials or extremely toxic dusts or sprays.
3. Change contaminated clothing as soon as possible and wash before re-use.
4. If pesticides are spilled on the skin, wash immediately and thoroughly with soap and water.
5. While spraying or dusting, prolonged exposure should be avoided, sprays and dusts should not be inhaled, smoking (especially hand-rolled cigarettes) should be avoided, and all exposed parts of the body should be washed immediately after.
6. Do not contaminate feed or water for livestock. Follow the rates of application shown on the labels, and strictly observe the cautions with regard to the use of treated crops.
7. Keep all pesticides in their original containers with proper labels. Store them in a safe place away from food or where food is handled. Keep out of reach of small children, pets, or irresponsible persons.
8. Destroy all pesticide containers by burying or burning and avoid smoke from such fires.
9. Equipment must be in good working order to avoid leaks and clogging, and should be thoroughly cleaned after use.

WHEAT STEM SAWFLY

Life history. The adults emerge from stubble during the latter part of June and fly for two or three weeks. The female lays her eggs inside wheat stems. Each will lay in about 40 stems. In less than a week the egg hatches into a larva that tunnels inside the stem. In August, the larva cuts the stem at ground level. It then plugs the upper end of the stub, which remains in the ground, and forms a cacoon in which it spends the winter. The larva changes into a pupa in May and about a month later the adult emerges.

Recognition. The adult, about 3/8 of an inch long, is mostly black, with two pairs of dark colored wings and with yellow bands around its abdomen. Because of its dark color, its small size, and its habit of flying close to the ground, it is seldom noticed. The larva is white, with a brown head and a small brown posterior spike. When removed from the stem the larva is S-shaped.

Infected stems after the second week in July usually contain "sawdust" and one or more nodes are hollowed out. After the wheat is ripe sawfly stubs are easily found by pulling up the stubble. Both stubs and stems cut by sawflies are recognized by their neatly cut ends plugged with "sawdust."

Control. Use of resistant or immune crops is the best method. Of the two resistant bread wheats, Rescue is more resistant than Chinook, but Chinook is superior in quality. Both depend on solid stems for their resistance; susceptible varieties have hollow stems. Prolonged cloudy weather during June and early July will produce less solid stems in Rescue and Chinook and reduce their resistance. However, the seed from these plants will produce solid-stemmed resistant plants if grown with adequate sunlight. Most durum wheats and barley have some resistance. When winter wheat is late in relation to the time of the sawfly flight it will be heavily damaged. Most crops with the exception of wheat, barley, and spring rye are immune.

Tillage methods. Shallow tillage will help as most larvae die in exposed stubs. The one-way disc or the discer are the best implements. They must be set to pass just below the crown of the plants to expose the maximum amount of stubble. Unless the stubs are left on the surface the operation is not effective. Fall tillage is effective between the first week in May and the first week in June. Burying the stubs only ensures good survival unless they are at least five inches below the surface.

Trap strips. These are strips of wheat wheat 10-25 feet wide next to the infested stubble. Most sawflies will lay their eggs in the strips, which must be cut shortly after the second week in July in order to destroy the larvae and eggs. Trap strips are more effective if seeded earlier than the main crops and if a bare strip of about 15 feet is maintained between the trap and the main crop.

Swathing early. If the crop is more than 25 per cent infested, it should be swathed slightly on the green side before it is cut by the sawflies. To determine infestation split at least 10 stems from the crop edge and examine for larvae or "sawdust." Make similar examinations at intervals of 10 paces into the

field. Infestation are usually heaviest at the margins. As at this time the larvae are low in the stems they are not killed and will appear the next year. Remember that sawflies, by feeding in the stems, reduce the yield in the infested plants by 10-20 percent; swathing early only prevents part of the damage.

Burning the stubble is not recommended. It does not kill the sawfly larvae but destroys beneficial parasites.

Present Status

The wheat stem sawfly has been at a low level in Alberta partially because of the large acreages of resistant or immune crops grown lately. In addition, the wet summer and fall of 1954 caused considerable reduction in numbers. The parasites of the sawfly, favored by late ripening crops, increased greatly in 1954 and have remained at a high level. In dry years maximum parasitism has been about 10 percent, but in the last few years it has reached 70 to 80 per cent. Most of the parasites overwinter in the stubble. Control should be continued since native grasses are permanent sources of infestation.

INSECTS IN FARM-STORED GRAIN

Insects will multiply rapidly in moist grain, causing it to heat. Grain that is uniformly dry will not spoil or become infested.

The common pests in stored grain are the rusty grain beetle, several kinds of fungus beetles and mites. Fungus beetles feed on molds in damp grain. They do not attack sound kernels. Larvae of the rusty grain beetle feed on the germ-end of wheat, oats, and barley. Mites feed on grain dust as well as on kernels. Grain infested with mites usually has a musty odour.

Preventive control measures are easier and more economical than curative ones. First, the granary should be swept thoroughly and made weatherproof. If the floor and walls are damp, sweep hydrated lime into cracks. Next, spray all inside surfaces with one gallon per thousand square feet: pyrenone (containing 2.0 percent piperonyl butoxide and 0.20 per cent pyrethrins); lindane (one pound 25 per cent wettable powder in 2 1/2 gallons water); malathion (10 fluid ounces 50 per cent emulsible concentrate in one gallon water); or methoxychlor (one pound 50 per cent wettable powder in one gallon water).

Allow about two weeks to dry. Do not put new grain on top of old grain. New grain often contains more moisture than old and will attract insects. Destroy old grain on the ground near the granaries. It usually contains insects. Keep ventilators open during dry weather.

Examine stored grain every two weeks. Feel with the hand and probe deeper with an iron pipe to detect "tough", damp, or heating grain. During warmer weather use water-proofed cups filled with water and sunk in the grain to within a half inch of the surface, three or four for each granary. Insects are attracted to the water and can be easily seen.

Move and clean infested grain during the winter. Infestations discovered in winter can be controlled by cooling the grain to 25°F. for seven to ten days. It should be cleaned and transferred slowly in thin layers during the coldest weather to piles outside or to another granary,. Put it through a fanning mill, combine, or threshing machine, or discharge it through a portable elevator into a sloping chute fitted with a six-foot section of screen. This will assist in cooling and drying.

Moving and cleaning grain in warm weather often gives satisfactory control when a good job is done. If not effective or possible, the only alternative is to fumigate.

Fumigation. A fumigant is usually applied as a liquid to the surface of the grain. It evaporates to form a poisonous gas that sinks through the grain. Fumigation is most effective on relatively dry, clean grain under warm, calm conditions. Use it in a tight granary or seal the cracks. "Tough," crusted, or mouldy and "hot spots" should be broken up before applying fumigant. "Hot spots" can often be more readily treated by direct application of fumigant through pipes. Before attempting to fumigate infested grain, obtain further details from the Crop Insect Section, Regional Research Station, Lethbridge, or your District Agriculturist.

Reference:

Dept. of Agriculture, Ottawa
Pub. 118—Control of Insects in Farm Stored Grain.

GRASSHOPPERS

Of several species, three cause most of the damage—the migratory grasshopper, the two-striped grasshopper, and the clear-winged grasshopper. These, and most others, start hatching early in May in a warm, dry year and continue over a month or more. The young grasshoppers, called nymphs, are only ⅛-¼ inch long. After growing and shedding their skin five or six times these nymphs become full-grown and winged sometime after the middle of June. A couple of weeks later they start laying eggs; this continues throughout the fall until cold weather arrives. The eggs are laid in the upper inch and a half of soil in compact clusters called egg-pods, from 20 to 100 eggs per pod, depending on the species. The number of

pods laid seems to depend on weather and on type and abundance of food.

A few species of grasshoppers lay their eggs in early summer. These hatch in late summer and the nymphs overwinter. The first warm weather of spring makes them active and causes reports of "early hatching." These are not injurious to crops.

Natural enemies—Eggs are destroyed by other insects as well as birds and rodents. Wasps, ants, and spiders prey on the nymphs. Both nymphs and grasshoppers are eaten by birds and small mammals. Some are infested internally by maggots of certain flies. A fungus disease is always present, and with proper weather can kill many grasshoppers and even destroy a serious infestation. The dead grasshoppers seen clinging to the top of tall weeds have been killed by this disease.

Where infestations arise—The two-striped and clear-winged grasshoppers concentrate their eggs on roadsides, headlands and pastures and the young nymphs move into adjacent fields. The other source is the eggs laid throughout the previous year's stubble fields mostly by the migratory grasshopper. Infestations from flights into an area are relatively rare and occur only when the general level of infestation across the prairie region is very high.

Crops attacked—Cereals, flax, and alfalfa are the crops usually attacked although in severe infestation almost any crop may be damaged. Tender vegetation is preferred, and the insects will move from ripening cereal crops to green flax or into winter wheat or cover crops. Adults can cause severe damage by cutting through the stem below the head, and dropping the head or flax bolls.

Fall sown grain and cover crops—These are a special problem in control. A comparatively few adults can cause heavy losses. They will move from the maturing spring-seeded crops into adjacent seedling crops and back again in the evening. Therefore, poison a strip inside the edge of the maturing crop as well as a strip inside the edge of the seedling crop. Several applications may be needed. Early seeding of the winter crop using a heavier seeding in the outer one or two rounds will help withstand damge.

Control—An annual forecast map is issued showing where precautions will be necessary. Stubble fields should be cultivated in the fall if practical. Spring cultivation is effective in starving young hoppers. Do not seed infested stubble fields. Cultivation of these fields will spread them to other fields. Such fields should be worked into narrow "trap" strips which can be poisoned before cultivation is completed. Summerfallow will have practically no eggs.

Poison is effective and inexpensive if done early. Watch for the young hoppers in ditch banks, headlands, pastures, crops in stubble, and crop margins. Poison when nymphs become numerous.

Aldrin, dieldrin, chlordane, heptachlor, and toxaphene are effective as sprays or dusts, killing by contact or as stomach poisons. Read the label on the container and use the rates recommended. Smaller rates are for young nymphs, the larger for older nymphs and adults or where longer poisoning is required.

Dusters and low-pressure sprayers may be used. Blower-sprayers or side delivery sprayers are effective for roadsides and fence lines. Aircraft are suitable for large areas or where ground equipment would cause damage.

Special situations—Where a poison residue on foliage is undesirable, bait may be used. Add 8 ounces of emulsifiable concentrate of chlordane, aldrin, or dieldrin to 10 gallons of water and mix with 100 lbs. of bran, or a bran-sawdust mixture (1 part bran and 2-3 parts sawdust) or a flour-sawdust mixture (3 part flour and 40 parts sawdust).

To avoid killing bees, as in alfalfa, by treating before bloom, use toxaphene spray in the evening. For pasture or cutting for feed, the minimum safety period from poison residue is: heptachlor—5 days; aldrin—2 weeks; chlordene, dieldrin or toxaphene—1 month.

References:

Dept. of Agriculture, Ottawa
Pub. 1036—Control of Grasshoppers in Prairie Provinces.
Pub. 86—Control of Grasshoppers in Vegetable Crops and Orchards.
Dept. of Agriculture, Edmonton
Chemical Control of Insect Pests.
Grasshopper Control in Alberta.

CUTWORMS

Cutworms are the larvae of moths ("millers") seen around lights during the summer and early fall. Cutworms are fleshy, soft-bodied worms that curl up when disturbed. Full-grown, they are about 1½-2 inches long; the upper half of the body is darker than the lower, and the backs and sides may be striped.

Most common cutworms pass the winter as eggs or partly-grown larvae. Damage is most serious during May and June. They usually feed at night, cutting off plants at or near the surface. Dry weather during the spring and summer favours increase, and outbreaks occur suddenly. Under these conditions examine fields frequently and apply prompt control.

PALE WESTERN CUTWORM

The pale western cutworm is the most common on the prairies. They are of a uniform slate-grey colour with a light yellowish head,

on the front of which are two, distinct, short black dashes.

The moth (adult) flies from about August 10 to September 15 and lays her eggs in loose, dusty soil, and these hatch early the next spring. The larvae feed on various green growth until late in June when they change to brown pupae and later to moths.

Prevent infestations by destroying all green growth on fallow during late July and leaving undisturbed by tillage, or livestock, until after September 15. In years of severe outbreaks, stubble fields should not be seeded.

Control by starvation—Very young cutworms can be starved in the spring by removing weeds and volunteer growth and delaying 10-14 days before seeding. The early growth should be 1-2 inches before cultivation. This method is recommended chiefly for stubble fields.

Chemicals may be used before damage is too extensive or just before reseeding. (See references).

RED-BACKED CUTWORM

The red-backed cutworm occurs most frequently in parkland areas or, occasionally, in sugar beets. They are moderately gray in colour on the upper half of the body and have two, broad, dull-red stripes along the back.

Moths lay eggs in late summer and early fall in loose soil. Hatching occurs the following spring and the larvae feed as soon as green growth appears. When full-grown, usually toward the end of June, they change to brown, inactive pupae, and later to moths.

Prevention—Use methods described for the pale western with one notable difference. Weeds should be destroyed in late July and fallow left undisturbed and crusted throughout August. However, if a heavy weed growth develops in August, it should be destroyed as moths prefer laying eggs in weedy summerfallow. They also lay in weedy patches in crops.

Control with insecticides is described in "Chemical Control of Insect Pests." (See references.)

OTHER CUTWORMS

The army cutworm occurs in southern Alberta and damages cereal crops, mustard, and flax. They are usually dark olive-green all over, sometimes with two rows of poorly defined creamy spots, or with a dull yellowish-brown band, along the top of the body. Eggs are laid in the fall. The larvae feed before winter, and are about half-grown by spring.

As this cutworm often appears quite suddenly in the spring, early examination of fields is recommended. They usually complete feeding before the end of May. If crops are seeded early or larvae are feeding later than normal, they can be controlled with insecticides. See "Chemical Control of Insect Pests."

The wheat head armyworm is found on the heads of maturing wheat, yellowish with broad stripes.

A variety of cutworms infest gardens and, in some years, are very destructive.

References:

Dept. of Agriculture, Ottawa
Pub. 62—Pale Western Cutworm Control.
Pub. 81—Cutworms.
University of Alberta, Edmonton
Bull. 24—Insect Pests of Grain.
Bull. 55—Insects of the Alberta Farmstead.
Canadian Sugar Factories, Raymond
Silver Sunshine (Insect Edition).
Line Elevators Farm Service, Grain Exchange Bldg., Winnipeg
Field Crop Insects in the Prairie Provinces.
Dept. of Agriculture, Edmonton
Chemical Conrtol of Insect Pests.

WIREWORMS

Description — Wireworms are hard-bodied, slow-moving "worms," varying from yellowish-white to straw color. They do not curl up when disturbed. Fully developed larvae vary from ⅜-1 inch in length, and have flattened, notched tails. This is the stage that causes damage. The adults are called "click beetles" because they spring into the air with a clicking sound when placed on their backs. No other beetles do this.

Life History — Wireworms take from 1 to 10 or more years to develop from egg to adult. In late July or early August, some of the oldest larvae come up to within 2-5 inches of the surface and pupate. The pupae change to beetles, which remain in the soil over winter. They appear on the surface as soon as the soil warms. Eggs are laid in May or June and soon hatch.

Early each spring the wireworms feed near the surface. As the surface becomes hot and dry, they go deeper. In irrigated lands they feed longer than in dry land.

Distribution — Wireworms occur in most fields, but damaging numbers are more common in light, well-drained soils; heavy soils are almost free. Under irrigation damage is usually confined to drier knolls and ridges.

Damage — In cereal crops is indicated by thin, patchy stands. The entire crop may be destroyed.

Wireworms first feed on seeds. Later they shred underground stems but seldom cut them off; these plants gradually turn brown and wither. Wireworms also bore into the central shoots of older plants, causing the central leaves to turn yellow, and tunnel into the tubers, stems, and roots of vegetable crops.

Choice of Crops — Wheat, spring rye, corn, and potatoes are very susceptible. Oats and

barley are more resistant, except late-seeded oats. Flax may suffer on new breaking, but generally escapes damage, as does winter wheat, fall rye, sweet clover, and alfalfa. Sugar beets can stand thinning without serious loss in the yield.

Control — Seed treatments containing aldrin, dieldrin, lindane, or heptachlor will give adequate control. The insecticide can be used alone or with a mercuric fungicide for seed-borne diseases See Page000) One seed treatment properly applied usually reduces wireworms so that little damage will occur in subsequent crops The seed for each acre is treated uniformly with one ounce of actual insecticide A higher rate will not help and may reduce germination Do not apply combination dressings to seed already treated with a fungicide Recommended farming practices, especially clean summerfallowing, should be carried out Watch for damage in future crops, and treat again when necessary.

Seed dressings should not be applied earlier than 5 or 6 months prior to seeding Longer storage may damage the seed and reduce wireworm control Follow label directions

Use good seed and seeding practices to increase plant vigour Avoid very early or very late seeding Seeding too deeply will reduce the effectiveness of the insecticide

Seed Dressings on Other Crops — Corn, peas, sunflowers, and beans may be safely treated with one ounce of lindane per 60 pounds of seed Combination dressings containing mercury should not be used on legumes such as peas and beans Sugar beets may be treated with four ounces of actual aldrin, lindane or heptachlor per 100 pounds of seed.

Chemical soil treatments are much more expensive than seed dressings but give better control for a longer period. They are recommended only for gardens or for sugar beets, potatoes, or other high-value crops.

Infested soil may be treated in fall or spring either with five pounds of actual aldrin or heptachlor, or ten pounds of actual chlordane per acre. It should be broadcast as a dust or spray and immediately worked in 4-6 inches deep. This should free the land for several years. Watch for damage each year and treat again when necessary.

Potato growers in southern Alberta have successfully used a band treatment of aldrin or heptachlar (dust or granules) at 1-3 pounds of the actual poison per acre, pre-mixed with fertilizer and dispensed from the fertilizer-hoppers at time of seeding.

Do not use lindane as a soil treatment on land where potatoes and edible root crops are to be grown because of the danger of taint and retarded growth.

Reseeding may be done on dry-land fields where a crop has been destroyed without danger or further serious damage.

Summerfallowing — Clean fallow every two or three years will reduce wireworms. Destroy all green growth during June and July. Do not work deeper or more often than is necessary for weed control.

SUGAR-BEET INSECTS

Beet Webworm

Primarily a pest of sugar beets, it will feed on mustard, safflower, flax, peas, and alfalfa. It prefers lambsquarters and Russian thistle.

Description. The larvae on hatching are pale green and about 1/16 inch long. They are found on the underside of leaves and hang by threads when disturbed. Fully grown larvae are 1 - 1½ inches long, olive-green with light and dark stripes. They pupate in the soil, are about 1 - 1½ inches long, and are constructed of silk covered with earth.

The adult is a grayish-brown moth with cream-colored markings on the wings, about ½ inch long with a wing span of about 1 inch. At rest, the moth appears triangular and is easily recognized by its short, rapid, zigzag flights. The eggs are small, pearly-white, and disc-shaped.

Life history. In June the moth lays eggs singly or overlapping in rows on the underside of the leaves. Eggs hatch in 3 - 5 days. Young larvae eat only the underside of the leaves, but as they grow they eat through and may leave only the veins. They develop so quickly they may cause considerable damage in one day.

Fully grown larvae drop from the plant and enter the soil to pupate. In about one month the moths emerge and start the second generation, which over-winters as pupae. Both May - June and August broods can cause reduction in yield and sugar content.

Control. Fields should be checked carefully during the moth flight for eggs and newly hatched larvae. Control should be applied early when more than one half grown larva per leaf is found on 50 per cent of the leaves.

Poison and application rates vary with crops. See "Chemical Control of Insect Pests" and your District Agriculturist.

SUGAR-BEET ROOT MAGGOT

The maggot feeds on the beet root, causing "bleeding" and wilting. Severe infestations may reduce yield by 3-8 tons per acre. The severest injury occurs during July and early August.

Then root-rot organisms enter the beet and cause further damage.

Description. The egg is white, slender, and slightly curved. The maggot (larva) is white, without legs, eyes, or a distinct head. It is largest at the rear, tapers toward the front, and is up to about ½ inch in length. The brown pupal case is oval and slightly shorter than the maggot. The fly is black, about ¼ inch long, with two transparent wings, each with a dark area on the front margin.

Life history. The maggot overwinters as a mature larva, 8 - 14 inches in the soil. In early spring it moves to 3 - 4 inch level and pupates. The fly emerges about thinning time and lays its eggs around a host plant. The maggots crawl below the surface. As the soil warms or dries, they move deeper. There is generally only one brood a season.

Control. Early seeding in well prepared and fertilized seed bed, followed by adequate irrigation, will reduce losses. Crop rotation and weed control along field margins and ditches also will help. Beets should not follow beets. For chemical control consult your fieldman.

SUGAR-BEET ROOT APHID

The principal summer hosts are sugar beets, table beets, lettuce, and lambsquarters. Others are spinach and Swiss chard. The aphid sucks the sap from the rootlets. If there are many the plants will wilt. Frost damage is more severe on heavily infested plants.

Description. Wingless aphids and a white mold-like substance will be noticed on the roots and in the soil. Late in the season winged aphids may be found.

Life history. The winter is passed either in the soil or as an egg on poplar trees. Beet crops may be infested from either source.. When poplar leaves open a wingless aphid hatches from each egg and lays its young. These develop wings and in June and early August fly or are blown to beets. In late summer and early fall, the winged forms fly to poplars and give birth to wingless males or females. After mating one white egg is laid in a crevice in the bark where it over-winters.

Control. The best method is to plant early, to irrigate early and frequently, and to keep soil fertility high.

Rotation is not effective and there is no satisfactory chemical control. An insecticide would probably destroy the predators that aid in control.

Crop	Pest	Description	Control (Follow manufacturer's directions for materials suggested)
Cabbage Cauliflower Radish Turnip Swede Turnip Rape	Cabbage Worm	Adult is white butterfly commonly seen in gardens. Larvae are velvety green caterpillars, up to one inch long, with a faint golden line down the back. Leaves and heads are severely chewed and green to black excrement pellets cling to the leaf surfaces.	DDT (not within 30 days of harvest, Derris, Pyrethrum (when heads are formed)
	Diamondback Moth	Caterpillars are light green with greenish brown heads, about one-third inch long when mature. They wriggle vigorously when disturbed. Similar damage to the leaves as the cabbage worm.	Same as above.
	Cabbage Looper	It is about the same size as the cabbage worm and does similar damage. It is distinguished by the peculiar looping of the mid-part of the body when it crawls.	Same as above.
	Flea Beetle	Adult is a small, shiny metallic green to black beetle that jumps rapidly when disturbed. Small holes are eaten into or through the leaves especially on young plants; these plants may be killed.	Same as above.
	Cabbage Maggot	Adult is a grey fly similar to a housefly in size. The larvae are white maggots that tunnel into the roots causing death of very small plants, especially trans-planted cauliflower and severely damaging the roots of turnips and radish.	Aldrin, (soil treatment before planting at 4 lbs. actual per acre)
Carrots	Leafhoppers	Small grey-green, wedge-shaped bugs that feed by sucking plants, also transmit the virus disease aster yellows. Adults jump and fly readily when disturbed. Disease usually not of economic importance in Alberta.	DDT, Derris (To prevent spread of disease treat at weekly intervals as soon as the insects appear.)

Crop	Pest	Description	Control (Follow manufacturer's directions for materials suggested)
Corn	Corn Earworm	Fully grown larvae are green to yellow and usually have conspicuous cream, yellow, brown or black stripes. Serious damage especially to early corn in some years when the larvae feed down the silks and into the tip of the ear. They never bore into the shank.	DDT (treat silks only, particularly early corn)
	European Corn Borer	Larvae are uniformly dirty white or pinkish, covered with rows of small brown spots, about one inch long when mature. Chew small holes in the leaves, then tunnel into the stem, causing tassel breakage. Worms will tunnel into the ear stalks and into the kernels.	A rare pest in Alberta; if found, report to your District Agriculturist.
Onion	Onion Maggot	Adult is a fly that closely resembles the housefly. The maggot is creamy white, legless, about one-quarter inch long when fully grown. It attacks the root causing young plants to wilt and die. Older plants have bulbs infested and may rot.	DDT, Dieldrin (seed treatment) Aldrin, Chlordane (soil surface treatment)
Potato	Colorado Potato Beetle	Adults are hard-shelled beetles about three-eights of an inch long, yellow with ten black stripes lengthwise on the wing covers. Larvae are soft-skinned, humpbacked, brick-red, with two rows of black spots on each side of the body. The grubs feed in clusters and completely consume the leaves.	DDT, Aldrin, Dieldrin, Chlordane.
	Wireworm	(See section on wireworms.)	
	Leafhoppers	(See carrots, above.)	

Crop	Pest	Description	Control (Follow manufacturer's directions for materials suggested)
Many garden crops	Slugs	These pests are soft-bodied, slimy, legless, about one inch in length, with no obvious head. They leave a trail of slime. Young foliage particularly is eaten, almost always at night except when it is wet and overcast during the day.	Metaldehyde, anhydrous copper sulfate and hydrated lime (one part to ten) scattered on the ground. Not effective when wet.
	Blister Beetles	Long, narrow beetles with the head quite distinct from the rest of the body, strong fliers, active on the plants. They may be black, grey, brown, or blue, and spotted or striped. Plants are stripped of their leaves very rapidly and are ragged in appearance.	DDT, Chlordane, Derris
	Aphids	Small, soft-bodied insects, somewhat larger than a pin head, often clustered in colonies. Most are green, but they may be pink, yellow, black or white. Aphids suck the sap of the plant, especially growing tips, and the leaves may curl and wilt. Some aphids are responsible for spreading many virus diseases.	Malathion, Pyrethrum, Derris, Nicotine sul fate
	Cutworms Grasshoppers Beet Webworm	(See respective sections.)	DDT, Derris, Aldrin
Cotoneaster Mountain Ash Plum	Pear Slug	Humpbacked, smooth, slimy, black and yellow insect that resembles a slug. They eat one surface of the leaves, resulting in a brown appearance that looks like premature ripening.	Malathion, in crawler stage.
	Oyster Shell Scale	Narrow, hard, grey-brown scales that may encrust whole areas of the branches. The crawlers are very small white insects that will infest the whole tree or shrub.	

Crop	Pest	Description	Control (Follow manufacturer's directions for materials suggested)
Currants Gooseberries	Currant Fruit Fly	Larvae are small white maggots that feed within the berries, causing discolored areas on the fruit and premature ripening. Adults are small flies that cluster in the bushes just prior to bloom.	DDT, control when 80% of the flowers have fallen and again in 10 days.
Gladiolus	Thrips	Very small, slender, brown to black insects about one-sixteenth of an inch long. The young are yellowish-green. Their feeding causes silvery streaks on the blossoms; spikes may be deformed.	DDT, treat corms before storing. Foliage spray when insects or injury evident during the summer.
Raspberries	Sawfly	Small, spiny, green caterpillars about the same color as the leaves. Cause tiny holes in the leaves at first, then skeletonize the leaves.	DDT, spray before blossoms open.
	Mites	Leaves speckled or blotched with grey patches, often fall prematurely. Mites are extremely small, white to green pests on the undersides of the leaves; they usually produce a webbing that becomes dusty.	Malathion
Roses	Rose Weevil	Dark red or red and black weevil that bores holes into the centres of the rose buds so that no flowers are produced.	DDT
Virginia Creeper	Leafhopper	Small, narrow, very active, pale yellow to white insects that feed on the undersides of the leaves. Leaves have small, white feeding scars; eventually the whole leaf turns white and drops.	DDT dusts; emulsions may burn the foliage.
Insects coming into the home from the garden	Clover Mite	Small, brown or red mites that swarm over walls especially in sunny exposures. They move into the house through the cracks around windows and doors.	Malathion, Aramite, residual sprays around the foundations and on the lawn for several feet away from the house.

Crop	Pest	Description	Control (Follow manufacturer's directions for materials suggested)
	Boxelder Bug	Red and black insects about one-half inch long. The young are a brilliant red color; feed on the box-elder leaves during the summer. In the fall the adults seek shelter in door cracks and around windows, etc.	Chlordane, Malathion
	Strawberry root Weevil	Rough, black, rounded beetles about one-quarter inch long, with a short snout on the head.	DDT
	Ants	Ants are easily recognized by the slender stalk connecting the head and thorax with the abdomen. They vary from one-twelfth to one-half inch in length.	Chlordane, apply over infested area.
Sweet Clover	Sweet Clover Weevil	Small inconspicuous, dark gray snout beetle, three-sixteenths inch long, chew crescent-shaped notches in leaves during whole season. Overwintering beetles destroy crop as it emerges in spring. Newly emerging beetles in early August destroy seedlings.	Seed new stands as far as possible from old. Use shallow tillage in late July, just after removing hay crop, to distroy insects. Spray with Dieldrin, Heptachlor, DDT, Aldrin or Chlordane.
Trees			
Spruce, pine, tamarack, balsam	Aphids	Clusters of small, soft, brown, green, or black insects on the trunks, branches, or twigs or amongst distorted needles at the tips of the twigs.	Spray trees thoroughly with Malathion
Caragana, maple, elm, poplar, willow, ash, fruit trees	Aphids	Leaves curled or discolored by small, soft insects that cluster on the trunk, branches, leaves, or seed pods.	Spray trees thoroughly with Malathion. For those types that roll or curl the leaves, e.g., elm, spraying should be done as early in the year as possible.
Caragana, ash, lilac, honeysuckle	Blister beetles	Blossoms and leaves devoured by swarms of large, active beetles.	Dust beetles with DDT or spray with Aldrin or Chlordane.

Crop	Pest	Description	Control (Follow manufacturer's directions for materials suggested)
Poplar, ash, birch, pine, spur	Borers	Trees or branches weaken and die; holes in the stems and branches, areas of dead bark, caused by white grubs burrowing in the wood. Grubs present all year.	Special treatment required. Send sample of grubs and damage to the Forest Biology Laboratory, 102 - 11 Avenue East, Calgary, Alberta.
Manitoba maple, elm, ash, fruit trees	Cankerworm	Small holes appear in leaves; later foliage is completely eaten by brownish-green caterpillars that spin silken threads. Present in May and June.	As soon as damage appears spray trees with DDT.
Manitoba maple, poplar, ash, elm, fruit trees	Cecropia Caterpillar	Leaves devoured in July. Young caterpillars are blackish, spiny; older ones are large, green, with vari-colored projections. Winter in large, brown, silken cocoons on twigs, weeds, etc.	Spray caterpillars with DDT. Hand-pick and destroy caterpillars and cocoons.
Poplar, willow	Leaf beetles	Foliage skeltonized by black grubs, causing scorched appearance, or devoured by small to medium vari-coloured beetles, from May to August.	Dust or spray with DDT
Most fruit trees	Tent caterpillar	Leaves eaten in May and June by dark hairy caterpillars that construct conspicuous tents of white silk.	Cut out and destroy tents during cool weather or at night. Dust or spray insects with DDT, derris, or pyrethrum. ,
Poplar, willow	Tent caterpillar	Leaves eaten in May and June by dark, hairy caterpillars that cluster on stems and branches but do not make tents; caterpillars often migrate in "armies."	Dust insects with DDT or spray with DDT.
Aspen poplar	Leaf rollers	Leaves rolled or curled in early spring. Small active caterpillars found in the leaf rolls; present in May and June.	Spray thoroughly with DDT. If area large, spray from the air with DDT. Contact the Forest Biology Laboratory, 102 - 11 Avenue East, Calgary, Alberta.

Trees	Crop	Description	Control (Follow manufacturer's directions for materials suggested)
	Bruce spanworm	Leaves eaten and partly curled. Active loopers or measureworms that spin down on threads when disturbed. Dark to light green in colour; present in May and June.	Spray thoroughly with DDT or, if large area, spray with DDT from air. Contact the Forest Biology Laboratory, 102 - 11 Avenue East, Calgary, Alberta.
Spruce, larch	Sawflies	Needles eaten by small green, brownish, or greyish-green "caterpillars" with shiny red or black heads; on spruce in June; on larch in July.	Spray insects with DDT, Aldrin, Chlordane, Toxaphene, or Malathion.
Spruce	Spruce mite	Yellowish mottling of needles with fine, silk webbing around twigs between needles; mites almost too small to be seen. Present from early May to end of season.	Spray trees thoroughly with Aramite 15% wettable powder, 1 pound to 20 gallons of water, or Ovotran 50% wettable powder, 6 ounces to 20 gallons of water, during second week in May and again about mid-June.
Spruce, pine	Pine needle scale	Yellowish mottling of needles caused by small, waxy, white, elongate scale insects that are present on the needles all year.	Spray trees thoroughly with Malathion 50% emulsion, 16 fl. oz. to 20 gallons of water, at the end of first week in June, and again during second week in August.

For further information on shelter belt and forest pests write to the Forest Biology Laboratory, 102 - 11 Avenue East, Calgary, Alberta. Send samples of insects and damaged plants.

Livestock

Livestock production is a major source of farm income and an indispensable part of balanced agriculture and permanent soil conservation. As breeding, feeding and management practices are improved there must be greater specialization within the industry. The individual farmer-producer may have to examine his operation with the view to greater specialization to meet competition.

Breeding, feeding and caretaking form the basis of live stock production. General principles, applicable to all classes of live stock, are set out herewith. It is well to understand these principles before undertaking a study of details.

Selection and Breeding

Consistent selection is the key to success in the genetic improvement of livestock. Only by culling the inferior individuals and retaining superior ones will progress be ensured.

Superiority must be measured in terms of economic worth. This includes weight for age, milk production, dependable reproductive performance and market suitability. Show ring standards tend to place undue emphasis on points other than performance. Livestock producers must seek other measures of economic worth in their selection programs.

Official Test Records

The Provincial and Federal Departments of Agriculture have made live stock testing programs available. The R.O.P. Policy for swine is an excellent guide to selection for rate of gain, feed conversion and carcass quality. Consistent use of R.O.P. records in boar selection is strongly recommended. For dairy cattle, R.O.P. and Dairy Herd Improvement Association tests supply information on milk and butterfat production that is invaluable in the selection of breeding stock. The Federal-Provincial R.O.P. policy for beef cattle, inaugurated in 1956 is designed to provide information on rate and efficiency of gain for this class of stock.

Test information may relate to the individual itself, to its brothers or sisters, to its parents, or to its progeny. The latter is known as the progeny test and, while the most difficult to obtain, is the most reliable as a measure of breeding worth. Sires whose offspring are above average performance should be continued in service as long as possible. Artificial breeding or the use of breeding crates can extend the use of proven sires.

Private Herd Records

Private records maintained by the breeder complement the official testing program. Such records often constitute the only basis for intelligent culling and replacement of breeding females. This is true for the commercial producer as it is for the breeder of purebreds. Minimum records consist of details of reproductive performance and mothering ability for each breeding female. To this should be added information on the vigor, growth and market performance of the progeny together with details of any defect such as dwarfism, ruptures, ridglings or intersexes (hermaphrodites). Families with inherited defects should be avoided.

Appraisal of the Individual

Selection is completed by appraisal of the individual itself. Vigor, weight for age, strength of feet and legs and mammary development are important. Number of teats has particular significance in swine and should be sought in the boar as well as the female.

In comparing animals from different herds, it is best to compare each animal with respect to its own herd average. Real genetic improvement can be expected only if the animals are above average in the desired traits.

Mating Systems

The mating system will depend upon whether the progeny are intended to be purebred seed stock or market animals. Producers of purebreds should use mild inbreeding or line breeding to promote genetic purity. This will permit greater accuracy in culling and will tend to develop a prepotent or true breeding line. When herd performance is high, inbreeding may become a necessity to avoid introducing stock of lower genetic worth.

Producers of commercial stock have the choice of crossbreeding or grading-up. Cross-breeding utilizes sires from two or more breeds while grading-up requires sires of one chosen pure breed. Either system will work well provided that selection is consistent and rigorous. In general, crossbreeding can be practiced successfully only in large herds and grading-up must be employed for the improvement of small one-sire herds.

The popularity of crossbreeding is due mainly to the increased vigor and growth in crossbred animals. Full advantage of hybride vigor is unlikely to be realized unless the crossbred female is used for breeding. This is particularly evident with pigs for which the increased vigor

of the hydrid dam can contribute materially to improvement in litter size and survival. Continuous cross-breeding, to yield satisfactory results, must be well planned in advance and the plan must be followed in detail.

Crossbreeding programs appear simple but they can lead only to mongrelization of the herd unless only young females are used for breeding in each generation OR unless sires of the two or more breeds are used simultaneously. The first alternative is impractical and the second requires large scale operations. Crossbreeding is not a cure-all for production problems. It may increase productivity if used in conjunction with but NOT as a substitute for good feeding, management and sanitation.

Grading-up has the advantage of straightforward simplicity. It is applicable to herds of any size and, since it presents no problems in the breeding of replacement females, is to be preferred to crossbreeding in small one-sire herds.

No breeding system will succeed unless based on sound seleciton. The choice of breed or breeds is secondary to the choice of the individuals which form the herd. Successful purebred or commercial breeding must utilize top quality purebred sires in every generation with selection, generation after generation, based on official as well as private records.

Artificial Insemination

has brought top quality sires within the reach of the many producers of beef and dairy cattle. As yet it has not been placed on a practical basis for swine.

The cost of artificial insemination is prohibitive unless an efficient service unit can be organized. Such a unit cannot operate on a practical cost basis unless at least 1,200 cattle are bred annually in an area of not more than 25 miles in radius, well serviced by roads and telephone. Producers of purebreds should also acquaint themselves with the ruling of their own breed organization concerning the registration of animals conceived artificially. For advice concerning artificial breeding write Live Stock Branch, Alberta Department of Agriculture.

Nutrition

The function of livestock on Alberta farms and ranches is to convert grain and forage crops into concentrated and highly palatable, protective human foods. Within limits livestock can convert rations that are not recommended into acceptable milk, meat, work or wool, but feed is wasted and cost of production increased when livestock are forced to make do with something less than a balanced ration.

Feed is the largest single item in the cost of producing livestock. Most of the nutrients required are present in the basal feeds—roughage and grain—but NOT in the proportions required by the animal. Thus profits are in large degree dependent on the producer's knowledge and the extent to which he applies his knowledge of:

(a) the nutrient requirements of his animals at all stages of the life cycle.
(b) the nutrient properties of the basal feeds.
(c) ways and means of supplementing the basal feeds to make rations nutritionally complete at minimum cost.

Study of Table I in relation to the following comments will give a working knowledge of the above three factors and furnish reasons for recommendations in the sections that follow.

DIETARY ESSENTIALS

Water

Water is a very important nutrient and is required in quantity by all livestock. Efficiency of production is lowered if for any reason animals consume less than enough.

Energy

Carbohydrates, mainly starches and celluloses in grains and roughages, and fats are burned in the body to provide energy. Surpluses build new body tissues, chiefly fat. Surplus protein can be used for the same purpose but the real function of protein is to provide the building blocks for new body or milk protein. All the basal feeds and supplements used in livestock rations furnish energy but not at the same cost. The relative amount of energy in different feeds is indicated by the total digestible nutrient (TDN) value. Requirements for different purposes is shown in Table I.

Bear In Mind

1. Lack of sufficient energy is a common deficiency in livestock rations—for ruminants one of the commonest.

2. Rations deficient in energy are frequently deficient in palatability and in protein, minerals and vitamins.

3. The inherent will to live compels livestock to eat enough of even the most unpalatable and unbalanced rations to maintain body heat and essential body functions.

4. It is only from feed beyond the maintenance level that livestock produce anything for their owner. This means that if an animal requires 9 lb. per day for maintenance, and the quantity consumed is 10 lb., the animal will produce something for the owner from **one-tenth** of the feed. If the quantity eaten is 18 lb., **one-half** of the total feed will go into something that the owner can sell.

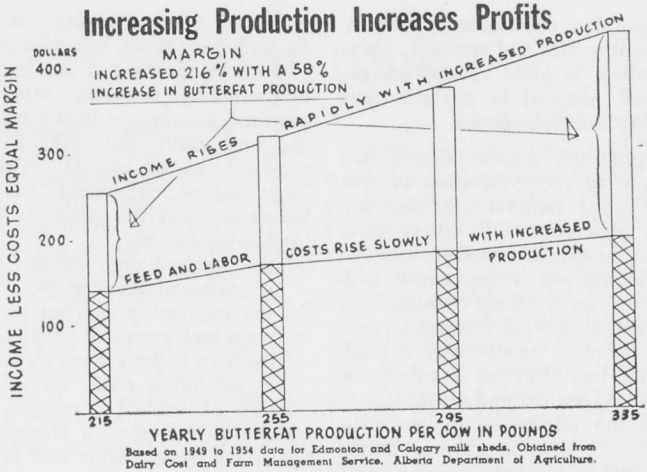


Fig. 1

FEEDING SCHEDULE FOR CALVES

Age	Whole Milk	Skim Milk	Grain Mixture	Hay
1st 3 days	8 lbs.	0 lbs.	Full feed whole or ground oats fresh daily.	Choice hay. No pasture.
4-7 "	9 "	0 "		
8-21 "	10-12 "	0 "		
22 "	11 "	1 "		
23 "	10 "	2 "		
24 "	9 "	3 "		
25 "	8 "	4 "		
26 "	7 "	5 "		
27 "	6 "	6 "		
28 "	4 "	8 "		
29 "	2 "	10 "		
30 "	0 "	12 "		
1-4 months	0 "	12 "	Full feed grain mixture.	
4-6 months	0 "	12 " if available	3-4 lbs.	Good hay or pasture.
6 months-1 year	0 "	0 lbs.	3-4 lbs.	
1-2 years	0 "	0 "	3 lbs.	

Don't force calves to subsist on pasture alone before 6 months of age. They will become pot-bellied and stunted.

Fig. 2

FEEDING CHART FOR GRAIN MIXTURES

FEED GRAIN MIXTURE ACCORDING TO MILK PRODUCED

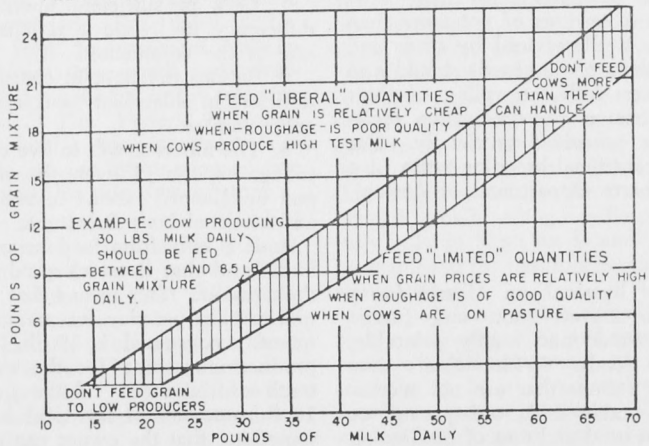


Fig. 3

5. Roughage feeds, other than lush pasture, are, even for ruminants, too bulky and too low in TDN content to provide for much beyond maintenance needs.

TABLE I
AVERAGE LEVELS OF SOME IMPORTANT NUTRIENTS IN COMMON FEEDS AND LEVELS REQUIRED IN RATIONS

	TDN %	Protein(1) %	Fiber %	Ca %	P %	Per lb. of feed Carotene mg.	Vitamin A I.U.
Cereal grains 76	12 (8-16)	6	0.06	0.37	0		0
Legume hays.....49	14 (8-16)	30	1.36	0.23	2-20		0
Grass hays.....46	7 (4-12)	32	0.34	0.15	2-15		0
Straws 42	4 (1- 5)	37	0.24	0.09	0		0
Vegetable pr't. meals 74	37 (20-45)	8	0.32	0.75	0		0
Animal prot. meals.. 68	55 (40-75)	1.5	8.0	4.3	0		0
Range (2) of levels required (no factor of safety) in rations for:							
Beef cattle 50-68	7.5-12.5			0.14-0.37	0.15-0.28	0.6 -3.6	or 240-1440
Dairy cattle	Requirements not commonly listed in this manner, but are higher than those for beef cattle because good dairy cows produce more lb. of edible dry matter per day than do beef cattle.						
Sheep 50-65	7.0-11.5			0.15-0.30	0.14-0.22	0.4 -1.0	or 215- 775
Swine 75-80	13.0-18.0			0.55-0.80	0.33-0.6	0.75-2.5	or 450-1500

(1) The bracketed figures indicate the range of protein levels that may exist in grains and roughages of the same general description, and in protein meals of different types. Similarly levels of other nutrients may differ markedly from the average values for a given kind of feed. See page 195 re services available for analysis of farm-grown feeds.

(2) Low levels for maintenance, high levels for growth or production.

PROTEINS

With the exception of ruminants which can utilize some non-protein nitrogen from compounds such as urea, animals can build or replace body proteins only from dietary proteins. Protein deficiency is very common in livestock rations.

Bear in Mind

1. Protein is required in amounts varying from 7 to 18 per cent or more of the total ration. The percentage necessary is highest during the more rapid stages of growth or production. Protein needs are higher for fast than for slow growing species.

2. It is apparent from Table I that:

(a) cereal grains do not contain sufficient protein for pigs;

(b) low grade roughages frequently contain insufficient protein to meet even maintenance requirements of ruminants;

(c) rations composed of average grain and good legume hays are likely to contain sufficient protein for beef cattle and sheep and to require relatively small additions of protein for dairy cattle.

3. Quality of protein is important for single-stomached animals, but less important for ruminants.

4. Compare prices of protein supplements on a basis of **cost per pound of protein — not** on a basis of price per 100 lb. of supplement.

MINERALS

1. **Common Salt**—All feeds of plant origin are deficient.

2. **Calcium (Ca) and Phosphorus (P)**

(a) Ground limestone is a cheap and effective source of calcium, but **it does not contain phosphorus.**

(b) Supplements containing useful levels of P —11%—are described as P supplements. With few exceptions they contain more Ca than P even without the addition of ground limestone. Good P supplements are justifiably more expensive than ground limestone. **Price per 100 lb of supplement can be very misleading.** From the guarantee on the container calculate what you are paying for a pound of P. If the price is $6.00/cwt. and the product contains 15% P, the cost per lb. of P is 40c; if the price is $4.90 and the P content 7%, you pay 70c per pound for P. If the product contains common salt,

calculate how much you are paying for salt.

(c) Note from Table I that grains are very deficient in Ca, but are fair sources of P. Legume roughages are rich in Ca. All roughage feeds tend to be deficient in P. Mature or weathered roughages are likely to be seriously deficient in this important nutrient.

3. **Iodine** deficiency is very common in Alberta feeds.

4. **Cobalt** deficiency may be a problem in rations for ruminants.

5. **Iron** deficiency is seldom a problem except in suckling pigs.

6. **Zinc**—See "Swine"—zinc supplements are not recommended for other farm animals.

Beware

1. Periodically mineral supplements for which ridiculous claims are made are offered to Alberta farmers at high prices by individuals or organizations who are not members of the Canadian Feed Manufacturers' Association. Apply the calculations mentioned in (b) under "Calcium and Phosphorus." Consult your District Agriculturist.

2. Be careful about vitaminized mineral mixtures—some real problems are involved in stabilizing vitamins in such mixtures.

3. If a ration is deficient in protein, NO mineral or vitaminized mineral mixture will replace a protein supplement.

VITAMINS

Vitamin A

(a) Deficiencies of this vitamin are common in Alberta.

(b) Requirements are proportional to body weight; they are higher for lactating animals and during the last one-third of pregnancy than at other stages.

(c) Green feeds contain carotene which is converted into vitamin A by animals, but carotene is quite unstable and easily destroyed by exposure to air, heat, light or minerals so that green color is not a guarantee of high carotene content in stored roughages. Vitamin A also is unstable and subject to destruction under the same conditions as is carotene.

(d) Grains contain no carotene; brown or black silages, weathered hays, straw and winter forage contain little or none.

(e) Buy carotene or vitamin A supplements from reputable sources. Calculate most on a basis of cost per milligram (mg.) of carotene per million international units (I.U.) of vitamin A—**not** on a basis of price per pound of supplement.

Vitamin D is required for the formation of bones. There is no vitamin D in grain and comparatively little in most other farm-grown feeds. Direct sunlight, acting on substances in the outer coat of livestock, forms vitamin D. Guard against vitamin D deficiency (rickets) especially in all young animals that receive limited or no exposure to direct sunlight.

Other Vitamins—Deficiencies of other vitamins in rations for cattle, sheep and swine are possible but not probable. Supplementation with vitamins other than A and D is recommended only under special circumstances.

BORDERLINE DEFICIENCIES OFTEN GO UNNOTICED BUT ARE THE MAJOR CAUSE OF LOSS

Economic losses due to **borderline** nutritional deficiencies are much greater than those attributable to **marked** or **complete** deficiencies. The effects of extreme deficiency in even one nutrient are so apparent that corrective measures are usually applied. Symptoms of borderline deficiencies are not dramatic and tend to go undetected. Inefficient use of feed, slow growth and fattening, low milk production, poor reproduction and high susceptibility to disease tend to become accepted as normal. The cumulative economic loss to the livestock industry is staggering.

Management

Management is merely the action program which applies the knowledge of breeding, feeding, the general care, and marketing of livestock, that has been accumulated through experience and research. Sound management entails considerable planning to attain maximum reproduction, maximum survival of offspring, maximum production from the feeds available and minimum loss from nutritional deficiencies, disease and parasites, in order to market to best advantage, a quality product which has been produced at the least possible cost per unit. Efficient livestock operations may appear to vary considerably, and this is rightfully so depending on such factors as:

1. the location and size of the farm,
2. the labor available and the degree of specialization,
3. the feeds most commonly available, and,
4. local marketing conditions.

This apparent variation in management is largely due to degree of application rather than a deviation from well established principles.

Livestock management tends to suffer if too many enterprises are carried on the farm. It is difficult under these conditions to have a good working knowledge of all the different enterprises, to provide the necessary equipment,

and to utilize available labor to best advantage. Continuity from year to year in the same enterprise provides the best opportunity for high efficiency and to avoid waste and added expense from frequent changes of breeding stock and equipment.

The main factors in livestock management are as follows:

1. **Feeding Practices** involve **chores.** They should take advantage of every possible labor and time saving device. Regardless of the size of the operation, consideration of location of equipment, feed, bedding and water can greatly reduce chore time. Feed and labor are two main operating costs in livestock production and efficient use of both can reduce per unit or per animal cost.

2. **Housing** varies from fairly simple for beef cattle and sheep to more costly for dairy cattle and hogs. It must provide adequate protection from cold, proper ventilation, ease of cleaning, convenience in location and layout. Construction should be of the cheapest possible design and materials, consistent with a good degree of durability.

3. **Equipment**—Fences, pens, gates, chutes, squeezes and hurdles, are essentials in handling stock with dispatch and satisfaction. Lack of this equipment results in wasted time and neglect of necessary practices and treatments.

4. **Comfort of Animals**—Animals react favorably to comfortable surroundings. Ample bedding during cold weather and shade during very hot weather has been proven to more than pay for the cost.

5. **Breeding**—Time of breeding should permit birth dates to coincide with weather, housing or other protection available, advantage from seasonal markets, and distribution of available labor.

6. **Care previous to Breeding** — Breeding females are more productive when in moderate condition, on a well balanced diet and gaining in weight when bred.

7. **Care During Gestation**—Pregnant animals should have ample exercise. Special attention to diet is necessary to assure strong offspring at birth. Most common deficiencies are protein and vitamin A.

8. **Care at Birth**—Profit or loss may depend on the degree of care at this time. Special attention is doubly important to ensure that young animals survice the first few hours.

9. **Creep Feeding** is important to supplement milk supply, increase gains during the nursing period and reduce the degree of change at weaning time.

10. **Weaning**—Ages and methods may vary considerably but this should be recognized as a critical stage in any animal's life and should be done systematically.

11. **Treatments and Operations**—(a) Cattle—Identification (tattoo, ear tag, branding); castration; dehorning; warble fly control treatment; louse control; foot trimming.

(b) Swine—Clipping eye teeth from piglets without injury to the gums or mouth, identification (tattoo, ear tag or ear notching), iron for suckling pigs, castration; segregating for uniform size in feeding groups, detusking aged boars, foot trimming of sows.

(c) Sheep—crutching ewes before lambing, attention to acute udder inflammation, mothering up lambs, identification (tattoo, ear tag, ear notching, fleece branding), docking and castration of lambs, shearing, proper care and packing of fleeces, dip or spray for external parasites, drenching for internal parasites, predator control measures as necessary, special attention to udders, mouths and wool when culling out ewes, foot trimming of ewes.

12. **Disease Prevention and Control**—Sanitation of premises, rotation of pastures and restricting visitors from feeding pens. Some diseases can be controlled by vaccines. In these cases vaccination should be standard practice. (see Veterinary section).

13. **Parasite Control**—Sanitation of premises and pasture rotation are leading factors. Parasite control measures should be routine with sheep husbandry. (see Veterinary section).

14. **Marketing**—Marketing systems are highly complex and not generally well understood by primary producers. As marketing is the final step in management, and price is the factor most likely to determine profit or loss, selling to advantage requires some study of markets. Two main divisions are usually available—the central market and the local market. The central market usually reflects a truer picture of supply and demand throughout the nation, particularly with respect to finished live stock. The local market has the advantage of less transportation cost but should be judged by the competition present. The rapid progress made by auction selling has been possible bacause producers desire to see open competition for tlieir product. Producers are cautioned against selling locally on one bid unless they are thoroughly familiar with central market quotations and freight differentials. They are also cautioned against allowing transportation agencies to do their selling.

15. **Records**—Herd performance and accounting. Evaluating the performance of animals in a herd or flock can only be done if certain minimum records are available. Factors here are: identification, rate of gain, feed consump-

tion and quality of product.

Only by accounting can the operator determine the value of his livestock enterprise in relation to his combined farm operation. (see Farm Management).

Beef Cattle

Efficient beef production can be achieved only through the application of superior production techniques. Management and feeding offer an immediate means of progress. Breeding and selection offer progress on a longer term basis.

MANAGEMENT

Size of Enterprise depends on the feed and pasture available. Flexibility and sufficient scale to provide a reasonable labor and capital return are essential. Recommended minimum numbers in the main commercial enterprises are:

1. production of feeders: 150-200 cows.
2. farm production and finishing: 50-60 cows.
3. buying and finishing feeders: 50-75 head.

In Choosing An Enterprise Bear In Mind:

1. Production of feeders maximizes the use of roughage but is the least intensive form of production, and is suited only to non-arable grazing land.

2. Farm production and finishing utilizes considerable grain, but usually must depend on the breeding herd utilizing non-arable pasture land.

3. Buying and finishing steers either in the feedlot or by grass and grain will maximize the use of grain and is the only form of commercial enterprise likely to produce satisfactory returns from high priced arable land.

Separation by age, size and sex provides for maximum production and utilization of feed. Each class of cattle should be fed according to its particular needs (See table 1, page 109) and principles of nutrition (pages 107 to 110).

Calves dropped early—at least 90 days before cows are turned on grass make the best use of their dam's milk and will be heavier on an age basis at weaning. Breed to calve in early March, only if facilities and labor are available to accommodate calving under adverse weather conditions.

Provide timely care and attention at calving—Calves may require Vitamin A supplementation if their dams have been on deficient rations.

Dehorn early—Recommended methods are:

1. Birth to two weeks (best time)—**Caustic** paste or pencil.
2. Birth to six weeks —electric dehorner.
3. Two to three months—tube dehorner or knife and caustic pencil.

Castrate early—Calves may be castrated at birth and should be castrated before they are three months. The knife is the only sure instrument for all ages. If the Burdizzo is used IT MUST BE USED WITH CARE to insure that the cord is fully crushed. This will avoid staggy steers.

Give timely attention to parasite and disease control—See page 148 for warbles and lice; page 140 for disease.

Heifers bred as yearlings if well grown will have greater life-time production than those bred as two-year olds. The rigorous nature of winter conditions and lack of adequate feed or calving facilities may necessitate delaying breeding until heifers are two-year olds.

Breeding bulls should be well exercised and conditioned but not over-fat when they are put with the herd. Do not use until fifteen months of age and then only on a limited number of cows (15-20). The number of cows per bull during a normal breeding season is somewhat dependent on the nature of the area and the management of the herd. The following is a guide:

Hand mating, 60.
Farm pastures, 40.
Open range, 30.
Rough range and bush, 20.

Housing—Brush shelters, deep coulees or board fences are usually adequate for all classes of cattle in the southern chinook area. In the northern area bush shelters and board fences will prove adequate for mature cattle; however, young stock should be afforded the protection of open front sheds.

FEEDING

Beef cattle production should be based on the maximum utilization of home grown feeds. Feed requirements and expected gains are set forth in table I.

Mineral supplements are required by most classes of beef cattle. Sodium chloride (common salt), Calcium, Phosphorus, Iodine and Cobalt are the only minerals likely to be deficient. Place a 50-50 mixture of salt, and either bone meal or dicalcium phosphate before cattle fed mainly hay or pasture. In addition have iodized-cobaltized salt available free choice. The only place for ground limestone in mineral mixtures for beef cattle is when they are on heavy grain feeding. See table I.

Vitamin A is the only vitamin likely to be lacking. Supplementation will be necessary when animals have been on grain and weathered roughages for extended periods (4 to 5 months). See "Vitamins" page 110.

Protein supplements are necessary only when roughage and grain quality are poor. See "Protein" page 109.

Silage can constitute the entire roughage ration for any class of beef cattle. If cut at the right stage and well cured it is a palatable and nutritious feed. It is a high moisture feed and in severe weather stock may not eat enough to meet their energy requirements. In such instances supplemental feeding with grain or hay may be necessary. Three pounds of silage is equivalent to one pound of hay.

Rolled or coarsely ground concentrates are most suitable for beef cattle. Calves may be fed whole oats.

Pelleting or cutting feeds for beef cattle is justified only where savings in waste, handling by mechanical equipment, and storage are sufficient to more than offset the additional cost.

Creep fed calves will be heavier at weaning. Creep feeding is not sound if calves are to be roughed through the winter or finished to weights in excess of 1,000 pounds. Suitable creep mixtures are half oats and half barley or all oats.

Sex hormones are used to increase growth and improve feed efficiency of feeder cattle. They should not be administered to breeding stock. Administer to feeder stock according to manufacturer's instructions.

Antibiotics—Their overall value is not clear. They appear to be of real value in reducing scours in calves and may be of special value in the feedlot when the animal is subjected to stress.

Tranquilizers have been variously reported to produce nil to significant improvement in rate and efficiency of gain and reduction in shrink of cattle in transit. At the time of writing tranquilizers have not been authorized for use as feed additives in Canada and no recommendation can be offered.

BREEDING AND SELECTION

The beef industry of Alberta is based on Aberdeen Angus, Hereford and Shorthorn cattle.

In herds of sufficient size to permit practical application, cross breeding can result in heavier weaning weights and growthier feeders, and the crossbred female may be a hardier and superior mother. This is true only if good parent stock is used. Seek scientific advice regarding your specific conditions.

Selection of beef cattle should be based on:

1. reproductive ability (longevity, physical soundness, regularity of breeding).
2. growth rate.
3. conformation.

Evaluate reproductive ability by keeping a herd book record which shows breeding and reproductive performance. This means cows and calves must be identified. Identify at birth.

Use a scale to evaluate growth rate and conformation to evalute TYPE. The nearer evaluation is made to the end product—a finished beef animal—the more accurate it will be as a criterion. Recommended times to weigh and evaluate type include:

1. weaning.
2. yearling or finished baby beef.
3. long yearlings (off grass in the fall).
4. finished long yearling bulls.

Cull parental stock if their progeny consistently give below average performance. SELECT FOR HERD REPLACEMENT those individuals that perform above the average and those from parents which consistently produce offspring with above average performance.

Any producer interested in adopting a system of selection based on performance should consult the Provincial Department of Agriculture for details of the Federal-Provincial Record of Performance program for beef cattle.

Further references on beef cattle production and feeding:

University of Alberta
- Bul. 57 — Cattle Finishing in Alberta

Department of Agriculture, Ottawa
- Feedlot Finishing of Cattle and Sheep in the Irrigated Areas of Southern Alberta
- Plans — Beef Cattle Housing and Equipment
- Pub. 955 — Feeding Grass Silage to Beef Cattle

FEED REQUIREMENTS, EXPECTED GAINS AND RATIONS FOR WINTERING AND FINISHING BEEF CATTLE

		Wintering Cow Herd		Wintering Calves	Finishing Calves		Finishing Yearlings	
		Farm	Range		Heifers	Steers	Heifers	Steers
Total (lb.)	Grain	Nil	Depends on Winter	300 - 500	1500 - 2000	1500 - 2000	1500 - 2000	1500 - 2000
Feed	Roughage	4000	Range — Have an Em-	2000	1200 - 1800	1200 - 1800	1200 - 1800	1200 - 1800
Length of Feeding (days)		200	ergency Feed Supply	200	160 - 200	180 - 200	100 - 140	120 - 160
Gain	Daily			.25	1.8	2.0	2.1	2.3
(lb.)	Complete		Nil	50	300 - 400	400 - 500	200 - 300	250 - 350

Rations and Special Problems (also see principles of nutrition page to .)

Cows can be expected to lose some weight, if their condition in the fall is good; however, if they receive a ration deficient in protein, vitamins or minerals, general health and reproductive ability may decline. Calves on adequate maintenance rations will make compensatory gains later. Winter rations should consist primarily of roughages but calves will require some grain when weather conditions are severe. Cows require about 2 lbs. and calves about 2.5 lbs. of feed per 100 lbs. of body weight for maintenance. Good quality roughage with some legume is preferred. Poor quality roughage is satisfactory if properly supplemented. Cattle entirely on roughage need mineral supplements. Feed bonemeal or other sources of calcium and phosphorus free choice.

To ensure good health and to guard against Vitamin A deficiency in newly born calves, pregnant cows on a poor quality roughage ration should be supplemented with 15,000 to 20,000 I.U. of stabilized Vitamin A and 1½ to 2 lbs. of a high protein concentrate per head per day. Wintering calves will require a similar amount of protein and 5,000 I.U. of stabilized Vitamin A per day if roughage quality is poor. Cattle grazing on winter ranges may require supplemental feed. The above supplement in pellet form is satisfactory. Heifers under three years and cows over eight to nine years frequently cannot withstand the rigors of winter grazing without extra roughage.

Wheat, oats and barley are the grains fed to feedlot cattle. The feeding value of screenings and of low grade grains resulting from drought, rust and frost is a direct function of their weight per bushel and they should be fed accordingly. At the start of the feeding period, a bulky ration of about ½ oats and ½ barley or wheat plus free access to roughage will safeguard against digestive upsets. As the feeding period progresses increase the portions of barley and or wheat and reduce the allowance of oats and hay. Cattle should be placed on feed slowly; start with 2-3 lbs. of grain daily and increase by a ½ lb. daily up to 7-8 lbs. Further increases should be made carefully as warranted by appetites. Cattle can usually be brought to self feeding in 20 to 30 days. Calves on full feed will consume 10 to 14 lbs. of grain and 4-5 lbs of roughage; while long yearlings will consume 20 to 25 lbs. of grain and 4-6 lbs. of roughage.

Feedlot cattle need a mineral supplement. Since rations are high in grain, calcium is in greater need than is phosphorous. A mixture of ½ bonemeal and ½ limestone is satisfactory if the portion of grain is moderate. On rations high in grain a mixture of ½ limestone and ½ salt, if roughage is a non-legume — if roughage is a legume feed only salt. If roughage quality is poor, feed a lb. per head per day of a high protein concentrate and feed 10,000 I.U. of stabilized Vitamin A after the feeding period has extended over 4 months. When cattle are allowed to self feed, cutting the roughage and mixing it with the concentrate will reduce the likeliness of animals going off feed particularly when the weather changes. During the cold weather, cattle will increase their consumption of grain, and if consumption is not restricted when the weather warms, scouring may result.

Salt and Water

All beef cattle should have free access to salt and water. Feed cobalt-iodized salt to guard against cobalt and iodine deficiencies. Remove the chill from drinking water in the winter and locate the water tank in an area sheltered from the wind.

Dairy Cattle

A high producing herd is basic to a successful dairy enterprise. Every individual planning to establish a dairy herd should consider:

1. Milk markets abailable.
2. Availability and opportunity for disposal of breeding stock.

A dairy herd may be maintained by purchase of all dairy stock or by breeding and raising replacements. The latter is recommended under most Alberta conditions.

Breeding and Selection

1. Use only purebred bulls or semen of bulls out of known high-producing ancestors. Good bulls can nearly double herd production in two generations.
2. Keep annual records of milk and butterfat production on every animal.
3. Cull low producers. Don't keep cows — make them keep you!
4. Retain heifers from cows that are regular breeders and high producers of milk and butterfat.
5. Large cows with strong frames, large barrels and large well attached udders produce the most milk. See Fig. 1 page 108.

FEEDING

Yearly Feed Requirements

Successful dairymen grow most of the pasture and other feeds required.

The following information is based upon a yearly requirement of an average cow weighing 1,200 pounds and producing 4% milk.

Roughage

Three tons, plus adequate grazing during the pasture season.

Pasture

2 to 2½ acres cultivated pasture in high productive areas with good soil and ample rainfall.

3½ to 4 acres cultivated pasture in medium productive areas with only fair soil and rainfall.

1 acre of good irrigated pasture.

3 acres native pasture or 10 acres bush land equal 1 acre cultivated pasture.

Minimum pasture requirements should be provided only when good management and rotational grazing are to be followed.

Concentrates

Level of Production Pounds milk per cow	Grain required with summer pasture (no supplement)	Grain required with winter feeding (no supplement needed with legume hay)	Amounts of a 24% protein supplement that should be included as a portion of the grain when a mixed hay or a grass or cereal hay (oat bundles) is fed.	
			Mixed hay	Grass or Cereal hay
6,000	200 lb.	1,000 lb.	175 lb.	400 lb.
8,000	500 lb.	1,600 lb.	280 lb.	650 lb.
10,000	800 lb.	2,100 lb.	370 lb.	850 lb.
12,000	1,100 lb.	2,700 lb.	475 lb.	1,100 lb.

Example: Cows with yearly production of 8,000 lb. milk being fed brome hay would require a total of 1,600 lb. concentrate mixture composed of 950 lb. grain and 650 lb. protein supplement during the winter feeding period, plus the 500 lb. grain required during the pasture season.
Note: The 24% protein supplement can consist of 60% wheat bran and 40% linseed meal.

Where the majority of the cows calve in the spring less protein supplement will be required, and there will be a larger proportion of the total grain fed on pasture.

Minerals

40 to 60 pounds cobaltized-iodized salt (blue salt) per cow per year. Add 1% bone meal to the grain mixture for high-producing cows.

Bedding

1,800 pounds per cow per year in a stanchion barn. 3,100 pounds per cow per year in a loose housing barn.

Young Stock Requirements

Calves: Milk 1,000 pounds (¼ whole milk and ¾ skim milk). Grain—900 pounds.

Hay—1,800 pounds. Pasture—from four months on.

Yearlings: Hay 3,600 pounds. Grain 1,000 pounds. Pasture—as for milking herd.

Winter Feeding

Best results are obtained when liberal amounts of good quality roughage are fed rather than large amounts of grain concentrates. The best hay for dairy cows is green colored, leafy, fine-stemmed legume or mixed grass and legume hay free from mould and weeds. Grass silage of good quality is an excellent roughage for cows and growing heifers.

Summer Feeding

Green pasture is the most nearly ideal feed for dairy cows. Excellent pasture is the most important single factor in economical milk production. In most areas of Alberta a brome alfalfa mixture gives the best results. Important considerations in pasture management are avoiding too early grazing, overgrazing, seeding, fertilizing and the control of weeds. Rotational grazing of four fields with the young stock following the milking herd is recommended.

THUMB RULES FOR FEEDING

Roughage

Feed 2 to 2½ pounds of roughage daily for each 100 lbs. live weight. Good quality roughage fed at maximum levels will reduce the requirements for concentrates. Silage can replace hay at the rate of 3 pounds for each pound of hay. See page 115.

SUGGESTED GRAIN MIXTURES

Grain mixtures will be largely determined by the roughages which are being fed and also by the feeds available. Five sample herd mixtures that will meet the requirements of dairy cows on different kinds of hay are shown in the following table:

A.—FOR COWS FED ONLY GRASS OR CEREAL HAYS:

	17% Protein Mixtures				
	1	2	3	4	5
	lbs.	lbs.	lbs.	lbs.	lbs.
Oats	560	700	575	500	400
Barley	.....	.....	.....	210	200
Wheat	.....	.....	150	.....	.....
Wheat Screenings	240	.....	.....	.....	100
Wheat Bran	.....	100	.....	100	120
Shorts	.....	.....	80	.....	.....
Linseed Meal	200	200	195	190	180
	1,000	1,000	1,000	1,000	1,000

B.—FOR COWS FED ROUGHAGES COMPOSED OF ABOUT ONE-THIRD ALFALFA OR OTHER LEGUME HAY AND TWO-THIRDS GRASS OR CEREAL HAYS:

	14% Protein Mixtures				
	1	2	3	4	5
	lbs.	lbs.	lbs.	lbs.	lbs.
Oats	560	740	600	600	780
Barley	250	.....	165	150	.....
Wheat	.....	.....	.....	.....	150
Wheat Screenings	130	.....	.....	.....	.....
Wheat Bran	.....	230	100	225	.....
Shorts	.....	.....	100	.....	.....
Linseed Meal	60	30	35	25	70
	1,000	1,000	1,000	1,000	1,000

C.—FOR COWS FED ROUGHAGES COMPOSED OF ABOUT TWO-THIRDS ALFALFA OR OTHER LEGUME HAY AND ONE-THIRD GRASS OR CEREAL HAYS:

	13% Protein Mixtures				
	1	2	3	4	5
	lbs.	lbs.	lbs.	lbs.	lbs.
Oats	850	750	700	740	700
Barley	.....	100	100	230	100
Wheat	.....	.....	50	.....	.....
Wheat Screenings	.....	.....	.....	.....	100
Wheat Bran	150	150	150	.....	100
Linseed Meal	.....	.....	.....	30	.....
	1,000	1,000	1,000	1,000	1,000

WHEN ARE MINERALS REQUIRED?

Salt—Provide access to a salt box outside. Add 1% salt to the concentrate mixture to ensure that heavy producing cows consume sufficient salt.

Iodine—Feed iodized salt.

Calcium is lacking in grass, cereal hays and grain. Plentiful in legumes.

Phosphorus is lacking when only roughages are being fed. Grains are rich in phosphorus. For heavy producers and growing heifers feed a supplement rich in both calcium and phosphorus, such as bone meal.

Cobalt—When only non-legume hays are fed the ration may be deficient in cobalt. Cobaltized-iodized salt (blue salt) is recommended. See page 115.

SUGGESTED GRAIN MIXTURES FOR CALVES BEWEEN 1 AND 4 - 6 MONTHS OF AGE

WHEN FEEDING SKIM MILK

	lbs.
Oats	39
Barley	30
Salt	1
Wheat Bran	30
	100

Above ration also suggested for feeding after 6 months without skim milk.

WHEN NO SKIM MILK IS AVAILABLE

	lbs.
Oats	35
Oat Groats	15
Wheat Bran	10
Skim Milk Powder	25
Linseed Meal	13
Bone Flour	1
Iodized Salt	1
	100

Commercial Calf Meals are recommended. They usually contain a variety of palatable feeds, minerals and vitamin supplements. Feed as directed by manufacturer.

Milk Powders or Milk Replacers—Reconstituted powdered skimmilk, made by mixing 1 pound of powder with 8 to 9 pounds of water makes an excellent feed for calf rearing. The reconstituted product can be used in the same manner and fed at the same rate as skimmilk.

Very satisfactory milk replacers are available. Calves should receive the dam's milk for the first three days, switching on the fourth day to a combination of whole milk, water and milk replacer. Generally, by the tenth day whole milk is no longer fed.

MANAGEMENT

The managerial ability of the dairyman may mean the difference between success or failure.

Housing—Two systems of dairy cattle housing are in common use:

1. Stall or stanchion
2. Loose housing with separate milking room.

For comparative information on the two systems see reference 1.

Dairy Bull — Keep the bull in separate quarters. A bull corral with a separate breeding stall is recommended. Exercising of the bull is important. Light service at 10 to 12 months of age is possible. Maintain the bull in a thrifty condition. Do not allow him to become excessively fat or thin.

Dairy Heifer—Young cattle should be kept in a good growing condition and making normal gains. Heifers that are well grown for age can be bred earlier than those that are underdeveloped.

Age to Breed

Breed	In Months
Holstein	18 - 21
Ayrshire	17 - 20
Guernsey	16 - 19
Jersey	15 - 18

Calving Time—Cows require a dry period of at least six weeks to restore body reserves for the following lactation period. Following calving do not breed back for 60 days.

Special care at calving includes:

1. Isolation in clean, well-bedded pen several days before due.
2. Feed limited quantities of feed that are laxative and fairly rich in protein, such as bran mashes.
3. Give aid only when necessary. Call veterinarian if condition is serious.
4. Allow cow to lick calf. Be sure fetal covering is removed immediately from calf's nostrils to allow breathing.
5. Offer cow lukewarm water to drink.
6. Continue feeding bran mashes for at least 24 hours.
7. Be positive cow has dropped afterbirth. Negligence here may ruin the cow.
8. Gradually increase concentrate allowance to required amount as congestion in udder subsides.
9. Observe closely for possible s igns of ketosis or milk fever.

References
Department of Agriculture, Edmonton
Pub. 7 — Dairy Barns for Alberta
University of Alberta, Edmonton
Bulletin 41 — Care and Feeding Dairy Cattle
Dairy Cattle Barn Sheet
Dept. of Agriculture, Ottawa
Dairy Cattle Housing and Equipment

Sheep

The Alberta sheep industry is roughtly divided into two main divisions, range and farm flocks. An economical range flock should contain a minimum of five hundred ewes. Farm flocks of less than forty ewes are of doubtful economic value and may range from that number up to two hundred ewes for maximum economy. Persons with little or no experience should start with a smaller number but plan to increase to these numbers.

While it is fairly common to purchase five or six year old range ewes it is recommended to start by purchasing (1) ewes under four years of age; (2) the larger ewe lambs out of feedlots in early March, or; (3) feeder lambs

and retain the best ewe lambs for breeding in the following fall. Competent assistance is essential to make careful selections of aged ewes otherwise heavy losses will offset any advantage in price.

Range flocks are basically of Rambouillet breeding to maintain high wool quality and the "banding" instinct.

The popular farm breeds are Suffolk and Hampshire, with more recent introduction of white faced breeds, North Country Cheviot, Carriedales and Columbias for crossing purposes.

FENCING

For active breeds such as Suffolk, Border Cheviot or North Country Cheviot, it is advisable to use 30" page wire topped with two strands of barbed wire. For more docile breeds five or six strands of barbed wire on posts one rod apart is adequate.

EQUIPMENT

Equipment does not need to be elaborate or expensive. A high fence made up of slabs with an open sloped-roof shed 20' - 24' deep across the north end of the corral is sufficient. Allow approximately fifteen square feet of shed and twenty-five square feet of corral space per ewe. A cheaply constructed lambing shed adjacent to the corral shed with artificial heat is required. Provide ten 4'x5' claiming pens for each fifty ewes. Confine the ewe and new born lamb in a claiming pen until the lamb is strong and nursing well. They may then be removed and penned with other nursing ewes. Where electrical power is available "lamb Creeps" may be built with 4'x8' panels with heat bulbs suspended at safe heights — such creeps may also be used to start lambs on creep feed of choice alfalfa and whole oats.

Sheds should be on high, well drained ground with southern exposure. Clean corrals and sheds as soon as sheep are turned out on pasture. Frequent summer use of wintering quarters is **not recommended** if sheep parasites and diseases are to be kept to a minimum.

PURE BREEDING

Those desiring to enter this field should first gain experience in the breeding, feeding and general management of a grade flock. Careful selection of foundation animals for size, uniformity, evidence of early maturity, clean dense fleeces and true type for the breed may avoid great disappointment later. Do not select on the basis of fancy pedigrees alone.

PROGENY OR PERFORMANCE TESTING

Testing of either pure bred or grade flocks provides the information necessary for selection of replacement females from parents that consistently leave strong, fast gaining, early maturing lambs. Consult local District Agriculturist or Alberta Department of Agriculture for detail information and necessary forms.

BREEDING PRACTICES

In smaller farm flocks pure bred ram lambs born January to March may be used for breeding in late fall. Very early ewe lambs may be bred in December; their progeny should not be kept for replacements. Under range conditions the use of mature rams and ewes is recommended. Mature rams may serve 40 to 60 ewes whereas ram lambs should not be used on more than 15 to 20 ewes. To ascertain ram fertility and breeding progress apply ochre (or some other washable coloring) on the breast of the ram. Ewes will be color-marked on the rumps as they are bred. Change color every sixteen to eighteen days; if too many ewes are marked by second and third services change rams.

In range flocks a percentage of Suffolk or Hampshire rams may be used for production of earlier maturing cross-bred market lambs. Retain only those ewe lambs sired by white-faced rams for flock replacements. If circumstances permit, a better practice for the production of replacement ewes is to run a separate band of selected white-faced ewes and rams. The balance of the ewe flock may be mated to black faced rams for production of market lambs.

On the range ewes are bred to lamb in April or May. Under farm conditions where adequate shelter and lambing equipment are available, it is advisable to lamb as early as January or February. Early lambs are usually ready for market when prices are high. To obtain a high percentage of twin lambs ewes should be "flushed" on good pasture, or fed one to one and one-half pounds of oats daily for three or four weeks before breeding.

Cross, or rotational breeding is recommended in farm flocks with only the best ewe lambs retained for breeding. These should always be mated to pure bred rams of a breed carefully selected to follow on the breeds already used. To grade up a sheep flock retain the best ewe lambs for breeding purposes; use unrelated rams of the same breed from year to year.

LAMBING PERIOD

Lambing areas must be dry and well bedded. Remove loose wool tags and dung locks from around the hind quarters and udders of ewes three to four weeks before lambing to facilitate nursing and prevent lambs from swallowing

wool balls. Separate ewes due to lamb within a few days and bring into lambing quarters for the night, especially so, when weather is cold in late winter or early spring. Make full use of claiming pens. Good feed and ample drinking water should be given ewes after lambing.

Lambs may be docked with a jack-knife before a week of age. Older lambs should be docked with hot iron or "Burdizzo." Rubber rings are not recommended. If knife is used to castrate at two or three weeks of age, carefully disinfect before and after castration. If "Burdizzo" is used crush left and right cords separately.

ORPHAN LAMBS

If at all possible, get a milking ewe to adopt the orphan lamb. This may be accomplished by smearing the "cleanings" from a ewe that has lost her lamb, or a ewe with one lamb only, over the orphan. Special attention may be necessary to see that the orphan nurses. If hand feeding is necessary the following procedure is suggested:

In the first two days, feed two to four tablespoons of milk from a high butterfat test cow five or six times in each 24-hour period. Add a few drops of concentrated cod liver oil to each feeding. Warm bottled milk in hot water to 100°F., use clean bottle and nipple for each feeding. Gradually reduce number of feedings to twice daily. Increase quantity at each feeding and allow lambs access to a creep feed.

PASTURE AND FEED REQUIREMENTS FOR SHEEP AND LAMBS

Ewe & Lamb	Acres Pasture - head Central Alta. 0.5 to 1.5	Acres Pasture Northern Alta 0.3 to 1.0		Acres Irrigated Pasture 0.1 to 0.2	
		Hay	Straw	Grain	Linseed Meal
Breeding ewe (during winter)		1000 lb.	some	150	10 lb.
Lambs-fattening		200 lb.	some	180	15 lb.

It is essential to provide plenty of pasture for sheep, however, legume pastures are not recommended because of bloat danger. Five ewes equal pasture requirement of one cow. To increase carrying capacity on seeded pastures and to eliminate worm infestation, not less than two, and preferably three pasture fields should be established and used for rotational grazing at ten to fifteen day intervals.

Winter Feeding—Ewes require four to five pounds daily of good quality hay, preferably a mixture of legume and grass. Three to five pounds of silage can be fed with liberal hay feedings — or as part of the roughage allowance. Silage alone is not recommended. Green oat bundles may be used only sparingly. If ewes are thin, ½ to 2 pounds of whole oats should be fed per ewe daily during the last two months of pregnancy. If hay is of poor quality one part of linseed meal should be added to four or five parts of oats.

Mineral Mixture—of 50 lb. blue iodized-cobaltized salt and 50 lb. bone meal or dicalcium phosphate should be self-fed to all sheep; in addition, blue salt should be provided in block or loose form in the winter as well as during pasture season.

Water—Remove chill. Drinking openings should be small.

Ewes must have ample opportunity for daily exercise. They must not be housed in totally enclosed warm quarters, except when lambing. Locating feed racks at least two hundred yards from the bedding area will enforce needed exercise.

Lamb Feeding—Feedlot lambs require very little protection other than a good windbreak. A good supply of water with chill removed is essential. Start lambs on good quality hay or legume-hay mixture and about one tenth lb. of whole oats per day per lamb. If quality of hay is poor, add 10% of linseed meal pellets to grain. Gradually bring lambs to full grain feed of up to two pounds per day in eight weeks. As the feeding period progresses, part of oats is replaced with barley. Grain should not be ground. Feeder lambs should have access to blue salt at all times. Self-feed some mineral mixture as recommended for wintering ewes. Lambs should be finished and marketed when approximately 100 lb. in weight. Under good hand feeding conditions, 100 pounds of gain may be expected on approximately 400 pounds of hay and 475 pounds of grain.

SHEARING

This is done by hand or power shears, usually in late May after danger of cold storms has passed. Sheep must be dry or wool will mold in the bags. The best shearing is done on hot days when grease rises in the wool. Use shearing platforms to keep wool clean and in one piece. Short, taggy, belly wool, black, and leg wool should be packed separately. A wire mesh or slatted 4'x8' table should be used for wool preparation. Spread the fleece weather side up on the table, take out undesirable parts;

fold one-third in from each side and roll from breech-end to neck and tie with paper string. Never use binder twine. Pack the fleeces tightly in bags obtainable from the Wool Growers Association or Wool Buyer.

PARASITES

Parasites must be controlled if the flock is to be thrifty and productive. The main external parasite is the sheep tick or ked. The entire flock should be thoroughly sprayed or dipped about a week after shearing. In badly infected flocks it may be advisable to dip or spray again in the fall before cool weather sets in. Lindane, D.D.T. and other suitable preparations are available from drug stores, wool handlers and live stock supply houses.

Internal parasites or worms can be well controlled by rotational grazing and the use of worm expellant preparations. Phenothiazine in fine powder form in liquid suspension is highly recommended. It is also obtainable and may be used in bolus form. Where pastures are not rotated all sheep should be treated for worms before turned out to pasture. Ewes should not be treated less than one month before lambing or sooner than a week after lambing.

For further details and alternate treatments see reference.

SHEEP IMPROVEMENT POLICIES

The Federal and Provincial Departments of Agriculture operate policies designed to assist commercial producers to obtain rams. Details can be obtained from the District Agriculturist.

References

University of Alberta, Edmonton
Bulletin 52 — Sheep Production in Alberta

Department of Agriculture, Edmonton
Sheep Housing Equipment Catalogue

Department of Agriculture, Ottawa
Bulletin 906 — Wool Production in Canada
Bulletin 886 — Range Sheep Production in Canada
Bulletin 786 — Feedlot Finishing of Cattle and Sheep
Bulletin 904 — Sheep Diseases in Canada

Horses

Even though the use of horses has been drastically reduced in recent years, there are still farm and ranch chores for which the horse remains the most economic source of power and transportation.

In their restricted use, it is more important than ever that horses be sound. Many defects are inherited but failure to care for feet, legs and teeth also will lead to unsoundness.

FEEDING

From 1 to 1¼ pounds of roughage and ¾ to 1 pound of grain daily for each 100 pounds live weight are recommended for working horses. Reduce the grain on light work or when idle. Oats are the standard grain for horses although the addition of bran improves the ration. Grass hays are preferred but mixed can be used.

In-foal mares need daily exercise and extra minerals. Keep a mixture of equal parts salt, limestone and bonemeal available to them at all times and starting in the fall, give a half-teaspoonful of potassium iodide in the feed or water every ten days up to foaling.

THE ORPHAN FOAL

Milk from a fresh cow, low in butterfat, should be used. Make up a mixture of a pint of such milk with a tablespoonful of sugar (dissolved in water) and from three to five tablespoonfuls of lime water. Warm to body temperature and feed about a fourth of a pint every hour from a bottle with a nipple. Reduce the number of feedings in a few days and teach the foal to drink as soon as possible. Lime water can be made by dissolving unslaked lime in water, allowing to stand for several hours and pouring off and using the clear liquid.

References:
Ontario Department of Agriculture, Toronto
Horses, Bul. 506

Swine

ECONOMIC RETURNS

Swine make a significant contribution to Alberta farm economy. With average annual marketings during the past 5 years of over 1,500,000 pigs, valued at $70 million, Alberta ranks second to Ontario in pig production.

Carcass quality is of particular importance as the consumer demands a lean product and this requirement is not being met by the majority of Alberta pigs. Alberta produces the lowest percentage of grade A and the highest percentage of grade C hogs in Canada. The average price differential of $6.50 between a grade A and C hog can easily represent the difference between profit and loss. Fat hogs are not cheaper to produce than lean hogs, in fact it costs more to produce fat than lean meat.

Hog production is rapidly becoming more specialized. It is probable that pork production will enter a phase similar to that of broiler production and that high efficiency and large scale production will be necessary to operate on a relatively narrow margin.

BREEDS AND BREEDING

The principles of selection and breeding in livestock are discussed on pages 106-107. Certain breeds are inherently more suitable for the production of high quality carcasses than others, but there are good and bad individuals within all breeds. Breeding stock should be selected with due consideration to records of performance.

Bacon breeds available in Alberta are the Yorkshire, Lacombe, Landrace, Tamworth and Berkshire. The former 3 breeds are white in color and have, on the average, desirable carcass characteristics. They probably are the the best breeds to use either in a purebred operation or in a grade or crossbreeding program. The colored breeds provide greater resistance to sunscald, an important consideration when pastures are used. Carcasses showing pigmentation cannot grade higher than B_1. On the average the Tamworth and Berkshire do not yield as desirable carcasses as the other 3 breeds mentioned. New breeds and inbred lines of meat type hogs have been developed in the United States but these cannot be recommended at present.

FEEDING

The principles of nutrition outlined on page 107 apply to pigs. For details on feeding and management see references on page 123.

Pigs fed balanced rations require 600 to 750 lb. feed from weaning to market. A sow requires 2,500 to 3,000 lb. of feed per year and this must be charged against her pigs. This latter figure emphasizes the importance of marketing large litters and getting 2 litters per year from a sow.

Grains form the basis of hog feeding in Alberta. Table 1 outlines suggested mixtures of grain and a complete protein-mineral-vitamin supplement or "35 to 40% commercial hog concentrate" which is usually the feasible method of balancing rations.

TABLE 1
Suggested Rations for Swine

Type of ration	Preweaning	Starter	May be combined Grower	Finisher	Sows°°° Pregnancy	Sows°°° Lactation
Weight of pigs..lb.	10-40	40-75	75-110	110-200		
Expected daily gain.....lb.	0.8	1.4	1.6	1.8	1.0 gilts 0.5 sows	
Average daily feed consump.°..lb.	0.5 creep 1.6 weaned	3.5	5.0	6.5	6.0	12-16
Barley and/or wheat .....%	Complete	50-85	50-85	42-67	18-38	38-63
Oats .....%	commercial	0-25°°	0-25	25-50	40-50	25-50
Alfalfa meal or hay .....%	mixed	0- 5	0-10	0-10	10-30	—.—
"35 to 40% Concentrate .....%	ration recom'd.	15-18	12	8	12-15	12-15

° On good pasture, feed intake of pregnant sow should be restricted to one-half this level.
°° Oat groats may be fed at much higher levels in the starting period.
°°° Boars should be fed similarly to pregnant tows with an increase in feed when breeding.

METHODS OF FEEDING

Self-feeding of market hogs is recommended because of low labor requirements. Self-feeding has little effect on rate of gain, feed efficiency or carcass quality when compared to full hand-feeding. Restricted hand-feeding will reduce the rate of gain but may improve feed efficiency and carcass grades. Self-feeding may produce comparable results if the ration is diluted with fibrous feeds such as oats or alfalfa meal. Sows should normally be hand-fed so that consumption can be controlled. A very bulky ration such as 25-30% ground alfalfa is required if sows are self-fed.

SUPPLEMENTAL FEEDS

PROTEIN

In a protein supplement for pigs the quality of protein is as important as the quantity. Proteins are built up of over 20 amino acids, 10 of which are essential for the pig, and it is the presence of the proper proportion of amino acids that makes some protein supplements more valuable than others. Vegetable oilcake meals, animal and fish by-products are the main sources of protein in commercial supplements. Skimmilk or buttermilk, if fed as recommended in Table 2, will replace other protein supplements, but will not supply all the necessary minerals and vitamins.

TABLE 2

Skimmilk and Undiluted Buttermilk for Pigs

Weight of pigs	Lb. skimmilk or buttermilk per lb. of grain
Weaning to 75 lb.	2.5
75-110 lb.	2.0
110 lb.-market weight	1.0
Sows	Free choice

Commercial protein-mineral-vitamin supplements are usually fortified with minerals, vitamins and antibiotics to meet the requirements of pigs as outlined below.

Pigs require 0.5 lb. iodized salt and 0.5 lb. ground limestone per 100 lb. total ration or free-choice access to a mixture of these minerals. In addition, pigs require 50 to 100 p.p.m. of zinc in the ration to prevent the possible development of parakeratosis, a disease of the skin accompanied by severe dermatosis (scurfiness) and unthriftiness. This disease usually occurs shortly after weaning. Zinc oxide, zinc sulfate or zinc carbonate at levels of ⅓ lb., ¾ lb. and ½ lb. respectively per ton of complete ration will combat this condition.

In addition to Vitamin A (1,000,000 I.U. for market pigs and 2,500,000 I.U. for breeding stock per ton of ration) and vitamin D (200,000 I.U. per ton of ration) it is advisable that riboflavin, niacin, calcium pantothenate and vitamin B_{12} be included in rations of young growing pigs to meet conditions of stress that may occur. Ten grams of antibiotic per ton of feed for growing hogs and 25-50 gm. per ton in creep feed and starter rations are desirable.

PASTURE

Pasture is recommended for sows and prospective herd gilts and boars but not for growing pigs if completely balanced rations are fed. Pasture may reduce labor requirements, provide more sanitary conditions and allow market pigs to balance their rations but it will decrease rate of gain and perhaps feed efficiency as compared to indoor rearing. An acre of good pasture will carry 10 sows, or 3 to 5 sows with litters. Annual cereal pastures are recommended for reasons of sanitation. The choice of pasture type is secondary to providing green forage for the entire growing season.

WATER

A pig requires about 2.5 lb. of liquid for each pound of solid feed. Water should be available to pigs at all times, preferably by automatic waterers, and it must be kept ice-free in winter.

MANAGEMENT

Principles of Livestock Management are given on page 110.

Sows should be flushed by placing on full feed one week before breeding until about 3 weeks after breeding. Then reduce feed to 4-6 lb. per day or 2-3 lb per day if on pasture and increase to 6-8 lb. about 1 month prior to farrowing.

Care at farrowing time is extremely important as this is when the heaviest pig losses occur.

Gestation period—112 to 115 days; or 3 months, 3 weeks and 3 days. Move sow into farrowing quarters one week before farrowing date.

Important points at farrowing time

(a) Warm farrowing quarters—artificial heat required.

(b) Clean and disinfect pen (1 lb. lye to 30 gal. hot water or recommended disinfectants).

(c) If weather permits, thoroughly wash udder and preferably the entire sow.

(d) A guard rail 8 inches from floor and 8 inches from wall, or use farrowing stalls.

(e) Avoid coarse straw and use a minimum amount of bedding.

(f) Be present when sow is farrowing.

(g) Remove "black teeth" with sharp nippers. Do not injure gums.

(h) Birth of hairless pigs indicates iodine deficiency.

(i) Birth of weak litters usually indicates lack of protein, minerals or vitamins in sow ration.

(j) Failure of sow to milk may be caused by: Ration imbalance during pregnancy, frequently a lack of protein and/or pasture. Too concentrated a ration prior to farrowing; use bulky feeds such as bran and oats. Lack of exercise; do not keep sow in farrowing barn for a long period prior to farrowing. Inadequate water supply; give sow all the warm water she will drink. Bringing sow on feed too rapidly. A fever lasting more than a few hours will stop milk flow; treatment with 1.5 to 3 million units of penicillin may be helpful. Milk letdown can sometimes be initiated by use of a hormone injection; contact your Veterinarian.

SOW AND LITTER

(a) Prevent anemia in suckling pigs. Give an iron compound by mouth at twice weekly intervals from 3 days to 3 weeks of age or inject an iron-dextran compound. See page 139.

(b) Supply creep feed beginning at one week of age. Water must be readily available to the youg pigs. Commercial preweaning rations are recommended. Such rations are too complex for home-mixing.

(c) **Orphan pigs** may be raised if they were able to get first milk or colostrum from the dam and if a program of extreme sanitation is followed. Commercial milk replacers are most desirable but the following formula has proven useful. Warm to body temperature.

Cow's milk	1 qt.
Water	1 pt.
Sugar	1 tsp.
Antibiotic supplement	approx. 0.25 gm. of antibiotic, preferably a soluble supplement.

Reduce water gradually and remove from the formula by the second week. Place dry preweaning ration in the pen at one week of age. Orphan pigs are very subject to ailments, and unless a producer is willing to spend considerable time, it frequently does not pay to raise them.

(d) Early weaning. Under practical conditions 5 to 6 weeks weaning is quite feasible and will usually give as good results as normal 8 week weaning, while freeing the sow for earlier rebreeding. Weaning at 3 weeks of age or 10 lb. in weight should be practised only by the specialized producer who can supply superior management. Unless a producer makes use of early weaning to get more litters from his sow it offers no advantage over normal weaning.

(e) Castration — male pigs intended for slaughter should be castrated prior to 6 weeks of age.

FOLLOWING WEANING

Once a pig reaches 50 lb. in weight it is past the most critical stage of its life but proper feeding and management cannot be ignored. Pigs of this age are still subject to diseases and parasites. (See Veterinary Section, page 139.)

(a) Pen area—Allow 6 sq. ft. per pig to 100 lb. and 10 sq. ft. per pig to market. Do not group pigs that vary widely in weight. If a pig shows signs of unthriftiness or sickness remove to a hospital pen. Crowding of pigs often contributes to tail chewing and cannibalism.

(b) Worm treatment—(See also page 139). Shortly after weaning treat for intestinal roundworms. Methods:

Sodium fluoride—Weigh the amount of feed to be fed for 1 day. To this add 1% by weight of sodium fluoride. This should be thoroughly mixed and must be fed dry. Pigs may be given water to drink in a separate container from the feed. Caution is advised as sodium fluoride is a poison.

Piperazine derivatives, cadmium oxide compounds or hygramycin—To be used as directed by the manufacturer.

(c) Market weight—To get maximum returns from hogs they must be marketed at 190 to 210 lb. liveweight to give carcasses weighing around 150 pounds. For pigs shipped a long distance such as from the Peace River 200-210 lb. is recommended but for short haul pigs 190-200 lb. is the best market weight range. A weigh scale is recommended for all hog producers.

BUILDINGS AND EQUIPMENT

Dep't of Agriculture, Edmonton

References:
Swine Housing Catalog
Swine Equipment Plans
University of Alberta, Edmonton
Bull. 22 — Swine Production in Alberta

Special Feeding Problems

Sickness, unthriftiness, and death losses among livestock may be caused by toxic substances in the feed or drinking water. The amount of toxic material that will cause death varies considerably with the class of live stock and their condition. In general, thin animals can tolerate less toxic material than well-fed animals. Where sickness, unthriftiness, or death losses do occur a veterinarian should be con-

sulted. The following includes the most commonly occurring problems in Alberta.

ERGOT

Grain containing more than one ergot body per thousand kernels is potentially harmful. The amount of ergot in grain can be reduced by putting it through a cleaning mill or by mixing it with non-ergotty grain. Ergot-infested hay or pasture also is dangerous.

MOLDY, HEATED AND FIRE-DAMAGED GRAIN

These are less palatable and of lower feeding value than normal grain but are usually not harmful to live stock. (Laboratory test for Toxicity not available). Because of their lack of palatability they are not suitable feeds for heavy feeding. Moldy or heated hay is usually less palatable to stock, and of lower feed value but is seldom toxic. (see sweet clover disease) Wood, nails and other material should be removed from fire-damaged grain before grinding or feeding it.

SMUTTY, RUSTED, SPROUTED AND FROZEN GRAINS

These are of lower bushel weights than undamaged grain. Weight of grain required per pound of gain will increase about 2% for each decrease in one pound per bushel. They are not toxic to live stock with the exception of flax (see Prussic Acid poisoning) and are usually as palatable as undamaged grain.

TREATED SEED GRAIN

Grain treated with fungicides or insecticides should not be fed to live stock as many of these compounds are very toxic. Many of the toxic ingredients are termed "accumulating poisons,"—a small amount may be fed safely but the poisons accumulate and may poison the animal.

NITRATE POISONING (Oat-Hay Poisoning)

Frost, drought, certain weed sprays, and heavy applications of high-nutrient fertilizers may cause nitrates to accumulate in growing plants. In Alberta, oats are more often affected than other crops but wheat, barley, and some grasses also may be affected. Pasture plants, hay or straw containing over 1.0 to 1.5 per cent nitrates as KNO_3 are usually poisonous. A high nitrate content is sometimes found in certain water. (See under Water.)

PRUSSIC ACID OR HYDROCYANIC ACID POISONING

Flax that has been frozen, hailed or otherwise damaged before maturity may contain toxic amounts of prussic acid. Amounts in excess of approximately 0.02 per cent of the dry weight are dangerous. To obtain analysis see page 195. (feed and soil testing service.)

"SWEET CLOVER DISEASE" (Bleeding Disease)

Improperly cured sweet clover hay or silage may mold and become toxic. Such damaged feed should be fed only occasionally or in limited quantities along with good roughage. It should not be fed during the latter part of pregnancy. Laboratory test for toxicity is not available.

WEED SPRAYS AND INSECTICIDES

Some of these are very toxic to live stock. The manufacturers' warnings on the container should be read carefully before using them.

GREASE, OIL, AND PAINT, ETC.

Some of the modern lubricants contain toxic ingredients, hence care is needed to prevent them getting into feeds through grinders, etc., and to prevent live stock from licking machinery. Dump old paint pails, storage batteries, ashes and other garbage where animals do not have access.

POISONOUS PLANTS

There are a number of native plants poisonous to live stock. (See references.) Animals deficient in salt or other minerals eat poisonous plants more readily than animals not deficient in minerals.

WEED SEEDS

Most of the common weed seeds are not harmful to live stock in the amounts commonly found in grain. When making up less than one quarter of the total concentrate mixture ground pigweed, wild oats or buckwheat, have approximately the same feed value per pound as oats. Wormseed mustard is highly unpalatable even in small quantities and stinkweed will taint milk and meat.

WATER

Seepage from corrals etc., may cause water to be high in nitrates. Water containing over 0.35 per cent nitrate is toxic to ruminants. Water high in mineral salts may not cause death but can cause general unthriftiness. Where the water is suspected an analysis should be obtained. This can be arranged through your District Agriculturist. Some algae or slime which grow on still water may be toxic to animals. (See Livestock Diseases page 144.)

References:

Dept. of Agriculture, Ottawa.
Feeding Value of Damaged Grain.

Dept. of Agriculture, Edmonton.
Pub. 38 — Weeds Poisonous to Livestock.

Dairying

ALBERTA'S DAIRY INDUSTRY

Number of farms producing milk	55,000
Number of Milk cows	275,0000
Total milk production, lbs.	1,544,948,000
Average milk per cows, lbs.	5,616
Farm value of milk production	46,795,000
Factory value of dairy products	$ 52,139,000
Number of licensed dairy manufacturing plants	126

Milk Utilization in Percentage

Butter	56.0	(Creamery 52.0, Dairy 4.0)
Fluid Milk and Cream	32.4	(Sales 22.6, Used on farms 9.8)
Milk for Manufacturing	7.8	(Ice Cream 3.6, Cheese 1.3, Concentrating 2.9)
Fed to Farm Animals	3.8	

LEGISLATION AFFECTING DAIRY PRODUCERS

1. THE DAIRYMEN'S ACT AND REGULATIONS
   - —Requires that producers use clean and sanitary methods in handling and caring for milk, cream and dairy utensils.
   - —Prohibits the dilution, adulteration, skimming, coloring or addition of preservatives to milk.
   - —Prohibits the sale of milk or cream which is unsanitary, contains a contaminating substance or appears to be unfit for human consumption.
   - —Prohibits the sale of milk from a cow:
     (a) known to be infected with a disease affecting the quality of milk or otherwise endangering human health;
     (b) giving bloody or abnormal milk;
     (c) produced during the period of mastitis treatment or within 3 full days following the last injection of medicine or antibiotics into the quarter; or
     (d) produced in the period of 15 days before or 3 days after calving.
   - —Provides for the control of weighing, sampling, grading and testing of milk and cream.
   - —Provides that the patron receive a complete statement with each payment including the grade and butterfat content for shipments of milk and cream.
   - —Provides for licensing and bonding of all dairy manufacturing plants as a measure of assuring payment to dairy producers.
   - —Prohibits price discrimination thereby assuring patrons the same price at any given time for the same quality of milk or cream.
   - —Prohibits the manufacture and sale of imitation dairy products.
2. THE PROVINCIAL BOARD OF HEALTH REGULATIONS made under authority of The Public Health Act:
   - —Requires that any producers of milk for human consumption shall obtain a certificate of registration from the Local Board of Health.
   - —Provides that every registered producer, who has reason to suspect that any person employed on his premises is suffering from a communicable disease possible of transmission through the medium of milk, shall notify the Local Board of Health within 12 hours.
   - —Requires that registered producers of milk shall provide a certificate from a qualified veterinary surgeon stating that all cows are free from tuberculosis.
   - —Requires that a milk house, used only for the handling and storing of milk and milk utensils, be provided.
   - —Requires that all milk be cooled within one hour after milking to 50° F. or lower and maintained at that temperature.
   - —Requires that all utensils and containers, used in the production, storage or handling of milk intended for human consumption, shall be of the proper design and materials and in good repair.
   - —Requires that all utensils and containers must be cleaned immediately after each usage, sterilized in an approved manner and used for no other purpose.
3. THE PUBLIC UTILITIES ACT empowers the Board of Public Utility Commissioners:
   - —To inquire into any matter relating to the

production supply, distribution or sale of milk.

—To prescribe the area or areas which shall be regulated or affected by orders.

—To prohibit any person or classes of persons from engaging in the production or distribution of milk unless authorized by the Board.

—To prescribe the terms and condition upon which milk may be produced or sold in any area.

—To approve and establish from time to time schedules of minimum rates at which milk shall be supplied having regard to the interests of the public and to the continuity of supply.

Areas currently under control of the Board of Public Utility Commissioners include:

Bowden, Calgary, Camrose, Crow's Nest Pass, Edmonton, Lethbridge, Medicine Hat, Ponoka and Red Deer.

MILK HOUSE REQUIREMENTS

—Every producer of milk intended for fluid sales shall provide a milk house.

—Floors shall be constructed of concrete or other impervious material.

—Only milk and cream and the utensils used in their production can be kept in a milk house.

—Milk houses shall be provided with adequate ventilation, artificial light and equipped with a screen to cover each opening.

—No animal or fowl shall be permitted to enter a milk house.

—Where a farm bulk tank is installed a milk house shall be provided which shall conform to regulations under the Dairymen's Act.

FARM BULK TANKS

—Before installing a farm bulk tank a producer must receive approval from the Local Board of Health.

—Farm bulk tanks shall:

(a) be used only for cooling and holding milk;

(b) conform to the 3-A Standards and have the 3-A Symbol affixed thereto;

(c) be of sufficient size to hold the milk of five milkings; and

(d) be properly cleaned and sanitized before re-use.

RULES FOR BETTER MILKING

Prepare the cow.

—Avoid excitement.

—Wipe and massage udders and teats with a clean cloth wrung out of a very warm disinfectant solution.

—Use separate cloths for each cow and wipe udder dry after washing.

—Milk the first two or three streams into a strip cup.

—Where flakes or abnormal milk is detected, place cow at end of milking line.

2. Milk fast.
   —Put on teat cups a half minute after washing the udder.
   —Use a timer, most cows will milk out in 3 to 4 minutes.
   —Strip by machine — when milk flow slows down, pull down on the teat cups with one hand and massage the udder with the other hand. **(It is important that the teat cups be removed immediately milk stops flowing)**
   —Dip teat cups in clean water and then a disinfecting solution between each cow.
3. Operate the milking machine according to manufacturer's directions.
   —Check pulsation rate and level of vacuum regularly.
   —Clean vacuum lines twice a year.
4. Handmilking requires.
   —Clean clothes.
   —Clean dry hands.
   —Quick milking.

PRODUCTION OF QUALITY MILK AND CREAM ON THE FARM

1. Basic Requirements:
   —A clean healthy herd housed in a clean well ventilated building with clean adjoining areas. Flanks and udders should be kept clipped and brushed or washed prior to milking.
   —Strict cleanliness of personnel at milking time.
   —An adequate potable water supply for the stock; for cooling purposes; and for all cleaning operations.
2. Essential equipment includes:
   —a milk house of suitable design and size;
   —stainless steel or satisfactorily tinned utensils;
   —a single service filter strainer;
   —detergents and cleansers suitable to the water supply;
   —chemical sterilizers (e.g. chlorine solution) for "rinse before use" purposes; (lye solutions, see Special Milking Machine Treatment)
   —stiff dairy brushes — do not use cloths or steel wool; and
   —a noncorrodable rack large enough for draining and storing all utensils.

3. Procedure for Cleaning and Sanitizing Utensils

The following procedures apply to all surfaces of utensils and equipment coming in contact with milk.

Operation	Material	Purpose
(a) **Rinsing,** immediately after use.	Cold or lukewarm water	To remove milk residue from utensils while still in liquid state. Prevents milk stone formation.
(b) **Washing** (scrubbing)	Detergent added to hot water. A stiff dairy brush.	To remove all the remaining milk remnants from surfaces.
(c) **Rinsing**	Clean, very hot water	To remove all traces of detergent. To heat the metal and thus assist in drying.
(d) **Draining**	Drain rack (see equipment)	A clean place to allow utensils to dry properly.
(e) **Sanitizing** — just before use by rinsing with a chemical solution	A bactericide such as a chlorine solution.	To effect a measure of sterilization of surfaces in which milk or cream comes in contact.

Cream separator bowls and spouts should be dismantled and treated as above after each using.

Special Milking Machine Treatment

In addition to cleaning and sanitizing as outlined above, milking tubes and inflations should be stored between milkings in ½% lye solution (2 tablespoons in 1 gallon of water). This helps remove the fat which has been absorbed by these parts at milking time.

To provide further cleaning and to extend their life, two sets of milking tubes and inflations are recommended. Each set is alternately soaked continuously for 7 day periods in a 5% lye solution.

4. Cooling:

—Immediate, fast cooling of milk and cream to at least 50°F. and preferably 40°F. is essential. Use a good thermometer.

—Low temperatures should be maintained during storage period up to shipping time. Prevent freezing.

—During shipping, protect milk or cream from extremes of temperature.

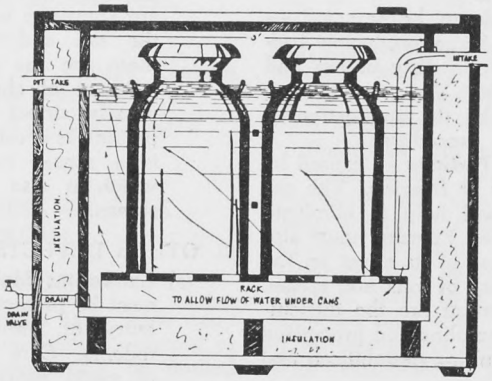
—Effective means of cooling are:

(a) circulating cold water in a tank of sufficient capacity; and

(b) mechanical refrigeration.

—Air cooling is not satisfactory for fast cooling. Experiments have shown that water cools 21 times faster than air at the same temperature.

PRECAUTIONS—Do not mix fresh warm milk or cream with the previously chilled supply. Always cool first — then mix if necessary.



"Farm Bulk Tank" showing refrigerating unit attached.

"Water Cooling Tank" located between pump and stock watering trough.

MILK AND CREAM DEFECTS OF FARM ORIGIN

1. FLAVOR DEFECTS OF MILK AND CREAM

Cause	Characteristic Off-flavor	Control
Bacteria—improperly sterilized utensils together with insufficient cooling and prolonged storage.	Sour or malty flavors, including stale, cheesey and bitter flavors of cream.	Adequate washing of utensil surfaces followed by effective chemical sterilization prior to use.
Feed—pasture and stall feeds with flavors that enter the milk in the udder via the digestive tract.	Feed and weed flavors — particularly stinkweed and other highly flavored plants.	When highly flavored feeds cannot be avoided they should be fed after milking or at least 3 to 4 hrs. prior to milking.
Inhaled Odors—some of these odors because of poor ventilation are absorbed directly by the milk but most reach the milk via the lungs and blood stream.	Barny flavors including silage flavor.	Provide adequate ventilation. Do not expose highly flavored feeds in the milking area prior to milking.
Fat Oxidation—more common during stall feeding season.	Cappy, cardboard or oxidized.	Provide good quality feeds. Avoid exposure of milk to copper equipment and light.
Hydrolysis or breakdown of butterfat by fat splitting enzymes. Relatively unknown during grass feeding season.	Rancid, bitter — on cream the flavor often referred to as "winter" flavor.	Check the milk of individual cows in fall and winter for occurrence of spontaneous rancidity. Avoid extreme temperature variations and unnecessary agitation.
Composition of milk—largely confined to advanced lactation. Milk sugar decreases while chlorides increase.	Salty	Limit length of lactation. Eliminate offenders by checking of individual cows.
Solution of copper or iron from utensils including shipping cans.	Metallic (tinny) — a puckery astringent flavor of iron salts.	Keep shipping cans and other equipment in good repair. Use only well tinned equipment or stainless steel.

2. PHYSICAL DEFECTS

(a) **Ropy Milk**—Tends to be seasonal — spring and fall. Slime producing bacteria enter milk from dirty udders and nonsterile utensils. The condition is easily controlled by the application of rigid sterilization procedures.

(b) **Flakes and Curd Particles** — caused by advanced mastitis or freezing. The use of a strip cup will help to eliminate mastitis as a cause. Freezing must also be avoided because of its effect on the physical appearance of milk and cream, but equally important are the difficulties of accurate sampling and processing caused by the resulting destabilized and oiled-off fat.

(c) **Difficult churning** — Seasonal changes in the hardness of butterfat and reduction in the size of butterfat globules are known to increase churning time in the fall and winter months. When these are the causes, an upward adjustment of churning temperature will usually correct the difficulty. Also important as a cause of delayed churnings is a rancid condition of the cream, which is also prevalent in the same season.

3. OTHER DEFECTS:

(a) **Extraneous Matter** — Milk and cream must be protected at all times from the entry of foreign material including rodents. Care must also be exercised to avoid contamination by pesticides, such as fly sprays, as some of these preparations are extremely toxic and

their use is prohibited in areas where foods are handled.

See section on insect pest control.

(b) **Preservatives** — Preservatives including formaldehyde are prohibited by law in dairy products and should never be used on milking equipment.

(c) **Antibiotics** — Residual antibiotics from the treatment of udders infected with the causative bacteria of mastitis must not be allowed to contaminate milk used for human consumption. Please refer to the section on legislation affecting dairy producers.

FACTORS CAUSING VARIATIONS IN BUTTERFAT TEST

Milk:

(a) Heredity — breed and individuality of the cow.

(b) Physiology — age, condition and stage of lactation.

(c) Enviornment — season of the year and time of freshening.

(d) Management — completeness of and interval between milkings. Exercise and feed.

(e) Miscellaneous factors — Health of cows and farm use of milk and cream.

Cream:

(a) Butterfat test of the milk.

(b) Position of cream or skimmilk screw.

(c) Temperature of the milk.

(d) Use of slime clogged separator bowl.

(e) Rate of inflow to bowl.

(f) Speed of separator — voltage changes affect speed of power separators.

(g) Amount of flushing of separator bowl.

FARM PROCESSING OF MILK AND CREAM

MANUFACTURED PRODUCTS:

A commercial market for farm made dairy products is practically non-existent. Interest in these products will consequently be limited largely to the requirements of the household. Instructive bulletins available are as follows:

(a) Buttermaking on the Farm — Farm Bulletin No. 52, Canada Department of Agriculture.

(d) Farm Cheesemaking — Joint Series Publication No. 5, available through District Agriculturists.

HOME PASTEURIZATION OF MILK.

Rural families can provide themselves with a safe milk supply. Healthy appearing cows are insufficient assurance that the milk will be free from contagious infection. The best protection is provided by heat treatment of all milk. The familiar double boiler, always available in the farm home, is suitable for this purpose. The milk in the vessel must be protected with a cover and stirred occasionally to insure uniform heating until a temperature of 160°F. is recorded by an immersed reliable thermometer. Rapid cooling of the milk should follow immediately. This can be accomplished by immersing the inner vessel of the boiler in a container of cold water.

Several types of electrically operated home pasteurizers are now available and may be purchased from dairy equipment distributors and mail order houses. For further information refer to Bulletin No. 43, University of Alberta.

USE OF DAIRY BY-PRODUCTS ON THE FARM

Cream shippers have a valuable food product in skimmilk. Well cooled skimmilk produced under strict sanitary conditions is an excellent food for regular table use especially if pasteurized. (See section on "Home Pasteurization of Milk"). As a feed for calves, hogs and poultry, it is one of the best farm produced feeds when used as a supplement to grains. To evaluate skimmilk as a feed, keep in mind that on the basis of protein alone "1,200 pounds of skimmilk is equal to 100 pounds of high protein supplement (35%)." In addition, skimmilk contains vitamins and minerals both of which are valuable to the growth and well being of young animals.

Buttermilk and whey, which are available to those farmers residing in the vicinity of creameries and cheese factories, provide a cheap source of excellent feed for pigs and poultry. Buttermilk is equal to, while whey is considered to be half the value of skimmilk. To feed these by-products successfully it is important that they be fed fresh with little or no increase in acidity, or allowed to sour. Wide variations in the method of handling buttermilk and whey are reported to result in serious digestive difficulties.

ALBERTA'S FROZEN FOOD LOCKER PLANT INDUSTRY — 1958

Number of plants operating.....	143
Number of lockers installed.....	44,196
Numper of lockers rented	32,992
Total pounds processed	16,711,266
Inspections during the year	1,158

LEGISLATION AFFECTING LOCKER PATRONS

The Alberta Frozen Food Locker Act and Regulations:

—Provides for the licensing and inspection of all plants that process and store frozen foods.

—Requires that satisfactory temperatures be maintained for the chilling, ageing, sharp freezing and storage of food products.

—Makes provision for sanitary plants and equipment in the processing of foods for freezing and storing.

—Requires satisfactory packaging materials and methods of wrapping of all food products for storage.

—Requires that all products be properly identified.

—Offers protection to patrons through compulsory and adequate insurance on food products.

REFERENCES:

Dept. of Agriculture, Edmonton
Annual Report, 1958
Pub. 99—Two Minutes to Wash Cream Separator
Pub. 93—Care of Milking Machines
Pub. 87—How About Your Milk Test ?
Pub. 6—Your Cream Test Goes Up and Down — Why ?
Pub. 5—Farm Cheesemaking

Queen's Printer, Edmonton
Dairymen's Act and Regulations
Frozen Food Locker Act and Regulations
Public Utilities Act

Provincial Board of Health
Regulations respecting dairy farms, milk plants, etc.

University of Alberta, Edmonton
Bul. 43—Milk and Cream defects of Farm Origin

Poultry

Poultry production in Alberta is still largely associated with the general farm, but increasing numbers of farmers depend upon poultry for their main source of farm income. They are engaged in commercial egg production, chicken hatching egg production, broiler production, turkey growing, turkey broiler production, or turkey hatching egg production.

COMMERCIAL EGG PRODUCTION

LAND REQUIREMENT

Where replacement stock is brooded and reared indoors the amount of land required is no more than that necessary for the buildings provided, and perhaps some allowance for future expansion. If, however, the rearing program involves the use of range, enough land should be available for range rotation, necessary for the prevention of parasites and diseases. The lighter the soil and the better the drainage the less land required. About 20 acres, divided into three ranges of equal size, should prove adequate for raising two thousand pullets.

BUILDINGS

General type and location—In general, three types of buildings are required; brooder houses, range shelters and laying houses. See references.

SIZE OF FLOCK

Poultry cost surveys have indicated that just about as much labor is required for two hundred birds as for four hundred. In addition, smaller flocks tend to be neglected, particularly during seeding and harvest.

An individual intending to earn his total income from a laying flock should keep at least two thousand birds and preferably five or more thousand.

STOCK

Breed—The important breeds might be divided roughly into egg-laying, general-purpose, and meat type breeds.

The Mediterranean breeds are generally referred to as egg-laying. Of these, only the Single Comb White Leghorn has attained very wide acceptance in the commercial field. More pureline White Leghorns and strain-cross White Leghorns are sold in Canada than any other breed. This is because the Leghorn excels most other breeds in egg production, efficiency of feed conversion, fertility and hatchability. The Leghorn lays white shelled eggs.

The general-purpose breeds are those that, in addition to being fairly good egg producers, are also good producers of meat. They are popular on general farms. Of the general-purpose breeds the most important are the Light Sussex, New Hampshire, and Barred and White Plymouth Rocks. These lay brown shelled eggs.

The meat type breeds are discussed under broiler production.

Quality—The best of feeding and management will not make birds produce that do not have the inherent ability to do so. Therefore, it is of prime importance that the poultryman should seek stock that possesses the inherent ability to live and to produce eggs of high quality through the laying year.

Number of chicks to buy—For replacement purposes this will depend on the percentage of the laying flock to be replaced, expected mortality during the growing period and the quality of stock obtained. It is customary to purchase 2½ to 3 times as many mixed chicks or 1¼ to 1½ times as many sexed chicks as the number of pullets one wishes to house in the fall.

When to buy chicks—To take advantage of high fall egg prices, replacement chicks should be purchased in February or March.

BROODING AND REARING

BROODING FACILITIES

Two types of housing are commonly used:

(1) the colony or portable brooder house

(2) the permanent brooder house.

The colony system involves the use of small portable houses located about 200 feet apart on range and these are moved at three or four week intervals during the rearing period.

Brooder houses vary in size and shape, but in general are 10' x 12', 10' x 14' or 12' x 12' in dimensions. (See references) Houses larger than this should be avoided because they are difficult to move.

Colony brooder houses are usually heated with coal, oil or propane gas; however, when drawn in close to the other buildings they often are heated with either natural gas or electricity.

A 10' x 14' brooder house is suitable for starting 250 to 300 chicks. More than 300 chicks in a house of this size will cause overcrowding and result in poor rate of growth, lack of uniformity, smothering, cannibalism or disease.

The colony system, when properly managed, is very satisfactory. Green range and sunlight tend to lessen nutritional deficiencies and re-

duce disease hazard. Rotating the range for use only one year in three and frequent moving of the houses during the brooding and rearing period results in a decrease in exposure to infection. The result is that range reared birds are usually hardy, vigorous, and have a good reserve of nutrients when they are moved into the laying house.

The permanent brooder house resembles a laying house in construction and sometimes is provided with a sunporch. The pen size may be large or it may be comparable to colony brooder house units. The use of the permanent brooder house system has become more common where brooding is not confined to a single season of the year.

Heat may be supplied by separate brooders in each pen; or by a central heating system of hot water, steam or heated air to provide a temperature of 70° to 75°F. In the latter case heat is supplied by continuous hot water hovers, gas or electric hovers or infra red lamps. In still others the use of radiant heating is employed.

RANGE HOUSES AND EQUIPMENT

Range houses are usually of "A"-type or open front construction, (see references) and are used for chickens that no longer require artificial heat. Range houses should be equipped with roosts with wire underneath, or slatted floors. Self-feeders and waterers also should be provided.

FEEDING AND MANAGEMENT

Cleaning—The brooder house should be thoroughly cleaned before the chicks arrive. Start with the removal of litter and droppings. Wash down the ceiling and walls to ensure that all dirt and dust is removed. The floor should be soaked and adhering litter and droppings removed by scraping and sweeping. Next, the floor should be treated with lye solution (1 can of lye to 5 gallons of water) allowed to soak overnight and finally scrubbed and washed with water. After the house has dried it should be thoroughly disinfected with a reliable disinfectant. The house should not be disinfected until it is thoroughly cleaned because disinfectants are relatively ineffective on dirty surfaces. All equipment also should be thoroughly cleaned and disinfected. Following cleaning and disinfecting, the house should be given a coat or whitewash. (See references)

Brooder operation—The brooder stove should be put into operation at least three days before the chicks arrive. See that a proper chimney jack is used and that the floor is protected against fire by a sheet of hard asbestos or other fireproof arrangement. Check to see that the stove is operating properly and that the temperature can be regulated. The brooder should be capable of maintaining a temperature of 95° to 100° F. at the edge of the hover two inches above the litter.

As the chicks age they require less heat. The initial brooding temperature of 95°F. should be reduced about 5°F. per week until it is down to 70° to 75°F when the chicks are 5 to 6 weeks of age. The behavior of the chicks is the best guide to temperature. If they are cold they will chirp and huddle under the hover while if they are too warm they will move away.

A room temperature of 70° to 75°F. is quite satisfactory for small chicks, and this may be reduced to 60° to 65°F. by the time the birds are 6 weeks old.

Litter most commonly used in the Prairie Provinces are wheat straw, shavings, peat moss or a combination of these.

During the first week of brooding, the litter under the hover should be removed daily. Later, weekly cleaning will suffice, and when the birds are outside most of the day, cleaning every two weeks will be adequate. Daily stirring of litter is recommended and water spillage should be kept at a minimum.

Floor space requirements—Approximately ½ square foot of floor space per bird should be provided to 4 weeks of age and one square foot from 4 to 8 weeks of age. With chickens in confinement, the floor space should be increased to 2 square feet per bird at 12 weeks of age and to 3 square feet at 16 weeks of age.

Ventilation—During the first few days of brooding, little ventilation, other than that provided by opening and closing the door, is needed. As the chicks age, more ventilation should be provided by opening the windows. On sunny days, see that sufficient ventilation is provided to avoid overheating.

Feeders and Waterers — From day-old to 4 weeks of age, chick size feeders should be used, at 1 foot of feeding space for each 10 to 12 chicks. At 3 to 4 weeks of age, intermediate size feeders should be introduced and the feeding space doubled.

At the start, 4 one-gallon fountains will supply the water required by 250 to 300 chicks. Initially, they should be placed on the floor, but as soon as the chicks learn to use them, they should be placed on low wire stands to prevent the chicks from coming in contact with the damp litter which is usually found around fountains. At 4 weeks of age larger fountains should be introduced. Water supply is extremely important. In the past few years it has been noted that heavy mortality

has occurred on farms where the drinking water is very hard. The water supply should be tested for hardness before being used for poultry.

Feeding — Use chick starter until chicks are 6 weeks of age. Provide chick size insoluble grit as an aid to utilization of the feed and development of the gizzard.

From 6 weeks to sexual maturity the birds should have access to mash (or concentrate) and grain and oyster shell on a free choice basis. The chick size grit should be replaced by intermediate size grit.

Feed Consumption — Two pounds of starter for each chick purchased should take care of the feed needed to 6 weeks of age, at which time the chicks are usually placed on growing feeds. Twenty to twenty-five pounds of feed is required to raise a pullet from 6 to 20 weeks of age.

Early Roosting — Forcing roosts should be lowered when the chicks are 3 to 4 weeks old and the chicks should be driven up on the roost each night until they go up of their own accord. Losses from smothering are less apt to occur if the chicks are roosting properly.

Getting the chicks out of doors — Weather permitting, get the chicks out of doors on clean land by the time they are 4 to 6 weeks of age.

Separate the cockerels and pullets at 4 to 8 weeks of age.

Range crops — Annual crops such as oats or rape or perennial grasses and legumes such as alfala or clover provide good range for poultry.

Experience has shown that land should be used one year for poultry and then cultivated for two years to destroy parasites and disease organisms in the soil.

Moving the brooder and range houses — The brooder houses or range shelters should be moved at least once a month in order not to over-contaminate the range in one area and to avoid killing the grass under the houses.

THE LAYING FLOCK

HOUSING

The laying house should be designed to provide maximum comfort for the birds throughout the laying year. (See Farm Plan No. 1, Laying House Plan)

Floor space — Heavy breeds should be allowed 3 to 4 square feet of floor space per bird, and light breeds 2½ to 3½ square feet. Forced ventilation, and ample feeding and watering space, may reduce the floor space required to 2 square feet per bird.

EQUIPMENT

Labor required for feeding and watering the birds, gathering the eggs and cleaning the house can be minimized by:

(1) Installing automatic waterers, either pressure or gravity.
(2) Using automatic feeders. If this is not feasible, use hanging or other types of feeders so that feeding may be done quickly and conveniently.
(3) Arranging the nests close to the door so as to reduce the time required to gather eggs.
(4) Screening off dropping boards or using dropping pits to facilitate removing droppings.
(5) Using the deep-litter system of litter management.
(6) Making provision for feed storage in the buildings (to make feeding easier and less time-consuming).

Nests — Some operators prefer individual nests while others prefer community type nests. Individual nests are usually about 12" to 14" wide, 14" high and 14" deep. One such nest should be provided for each 5 to 6 layers. Community nests 2'x4' or 2'x6' are common. A community nest 2'x4' should be provided for each 50 layers.

Feeders — High producing flocks should have at least 33 linear feet of feeding space per hundred birds. Feed troughs for laying birds should be about 18" off the floor and should have reels to keep the birds out of the feed. The troughs are usually about 6" deep and 8" wide, have flat or V-shaped bottoms and a lip to reduce feed wastage.

A recent trend in larger flocks has been toward the use of automatic feeders, but these are not economical in flocks of less than 1,000 birds.

Feed storage — A bin should be provided in the building.

Waterers — The use of automatic waterers in the laying house is desirable and will greatly reduce the labor required. If these are not employed, use sufficient water fountains or troughs to supply 3 to 5 gallons of water per hundred birds per day. Waterers should be placed on stands or over the dropping pits if the latter are present.

Perches — Should be built in sections that may be easily raised to facilitate cleaning of the dropping boards or pits. They may be made of 2"x2" material, rounded on the edge and set 13" to 15" apart. Six to eight inches when it becomes damp or dirty. This procedure necessitates removal of litter at least

of roosting space should be allowed for Leghorns and 10" to 12" for heavies. The perches should not be more than 3' above the floor.

Either dropping boards or dropping pits may be used in conjunction with the perches. Dropping boards are generally built in sections and are located about 30" above the floor. Dropping pits are usually about 18" deep.

Whether dropping boards or dropping pits are used, they should be screened off to keep the birds away from the droppings. Fourteen gauge 1"x2" mesh welded wire or 2" hexagonal fox wire is very satisfactory for the purpose. In place of perches and wire over the pits, 2"x2" wooden slats spaced 1¼" may be used.

MANAGEMENT OF THE LAYING FLOCK

Cleaning — Before the pullets are moved into the laying house, the equipment and the house should be cleaned, scraped, washed with water and scrubbed with a lye solution (1 can of lye to 5 gallons of water) and allowed to soak overnight. It should then be washed again with water, disinfected by spraying with a good disinfectant and whitewashed.

Litter — Wheat straw is satisfactory, and is usually available at a low price. Shavings or peat moss or a combination of same may be used, but are usually more expensive than straw. Shavings do not absorb very much moisture, and require to be changed often. Peat moss has a much greater moisture holding capacity than either straw or shavings but tends to become very dusty.

There are two common methods of managing the litter. The conventional method has been to keep the floor of the laying house well covered with clean dry litter which is changed every two weeks during the winter and once a month during the summer.

A newer method of litter management, and one that has received wide acceptance in commercial flocks, is the use of "deep-litter" or "built-up" litter. Four to six inches of litter is placed in the laying house prior to housing the pullets. It is usually done in August or early September so that fermentation will commence before the weather becomes too cold. Clean litter is added at intervals until the litter is eight to ten inches deep, which is sufficient, but the litter should be stirred regularly. Under this system the litter, if properly handled, needs to be changed only once a year. If the litter becomes wet, the addition of hydrated lime is recommended at the rate of about 10 pounds per 100 square feet of floor area and well stirred into the litter.

Time of housing — The pullets should be housed as they are coming into lay. Continue the same feeding practice that was used on range for a few days until the birds become accustomed to the new quarters.

Artificial illumination — is used on the laying flock to stimulate egg production. One 40-watt bulb, equipped with a reflector, six feet above the litter may be used for each 200 square feet of floor space. In houses up to 24 feet wide a single row of lights is satisfactory, but in houses wider than this a double row of lights should be used.

The use of sufficient artificial light to give the birds a thirteen to fourteen hour light day is usually started in the fall when the pullets reach their peak of production and is continued through until spring when the lengthening of the hours of daylight eliminates the need. In addition to using artificial light to stimulate winter production, lights should also be employed at the end of the laying year to prolong production, and following the annual moult to bring layers back into production.

FEEDING OF THE LAYING FLOCK

The all-mash system—In this system the entire ration is fed in ground form. No whole grain is fed. With this method there is less likelihood of hired or unskilled labor making a mistake.

The chief disadvantages of the all-mash system of feeding are:

(1) All of the ingredients have to be ground.

(2) There is sometimes a tendency for pullets to lose weight in the fall when they come into peak production. If the loss in weight is not checked, some of the birds are likely to go into a pause. This may be avoided by increasing the proportion of high energy feeds such as wheat and by decreasing the proportion of oats, barley and mill by-products in the laying ration.

(3) The litter and dropping boards tend to be wetter when an all-mash ration is fed than when a mash-grain or concentrate-grain system is used.

The mash-grain system — involves feeding a laying mash (containing about 18% protein) with scratch grain. Laying mash may be purchased ready-mixed or may be made by mixing 100 lbs. of 35% protein laying mash concentrate with 300 lbs. of ground grain (150 lb.s ground wheat, 75 lbs. ground oats and 75 lbs. ground barley).

A suggested schedule of feeding is as follows:

(1) Keep laying mash in front of the birds at all times.

(2) Feed 12 lbs. of scratch grain (two parts

wheat, one part oats by weight) per 100 Leghorns or 13 lbs. per 100 heavies per day. One-third of this may be fed in the morning and two-thirds in the evening about an hour before the birds go to roost.

The concentrate-grain system — In this system laying concentrate (usually pelleted) is fed along with scratch grain. The system permits maximum use of home-grown grains which not only do not have to be ground but may be self-fed in hoppers.

The main disadvantages of the system are:

(1) Feed efficiency is reduced slightly.

(2) Individual birds may consume different proportions of grain and concentrate resulting in variability in yolk color.

(3) If concentrate and grain are fed in separate hoppers on a free choice basis the birds tend to consume a higher level of protein than is necessary to maintain a high rate of egg production. Since protein is an expensive part of the ration this increases the cost of egg production.

Regardless of the feeding system employed oyster shell, insoluble grit and clean water should be available to the birds at all times.

Feed consumption — The amount of feed required for a laying hen is dependent on a number of factors such as the weight of the bird, the rate of egg production and the energy content of the feed. In general, the larger the bird the more feed is required for maintenance. As the rate of production increases, extra feed above that required for maintenance, is needed for egg formation. In addition, the feed required per bird per day is more or less directly related to the productive energy content of the ration. Thus, on high energy rations (rations high in wheat and low in oat and barley content) proportionately less feed is eaten than on lower energy rations (rations low in wheat and high in oat and barley content). This factor may be of considerable practical importance to the producer. A high energy feed, though more expensive per pound, may result in lower production costs than can be obtained on a low energy feed. Value of a feed should not be based on the cost per ton, but rather on the cost of feed required to produce a unit of product, such as a dozen eggs or a pound of poultry meat.

CULLING THE LAYING FLOCK

Culling the flock is a most important activity. It removes sick birds and poor producers and so increases the average quality of the birds that are kept. It reduces the amount of feed required to produce a dozen eggs and thus improves the efficiency of production.

Two types of culling may be used. **Continuous culling** refers to the removal throughout the laying year of obviously sick birds and those definitely out of production. In **systematic culling** the birds are crated, handled and the culls are removed. This entails a good deal of labor. As a result, this type of culling is usually only done a few times during the laying year. If a good strain of chickens is obtained, and only good quality birds are put into the laying house, systematic culling should not be necesary until the birds have been laying for eight months. Monthly culling may then be necessary until the end of the laying year.

MAINTAINING EGG QUALITY

To ensure high returns from egg production it is essential that eggs of high quality be produced and that the quality be maintained until the eggs reach the consumer. Feeding and management factors influencing egg quality:

(1) If possible, obtain a breed or strain of birds that is known to lay eggs with a low incidence of blood and meat spots. Generally speaking, Leghorns produce fewer blood and meat spot eggs than certain of the heavy breeds.

(2) Feed a balanced laying ration and supply oyster shell free choice to ensure good shell quality.

(3) Keep the laying flock confined. Birds that are allowed to range at large tend to consume too much green feed and as a result lay eggs with dark yolks.

(4) Do not have males in the pens except during the breeding season. The germinal discs (referred to as germ spots) of fertile eggs undergo development on exposure to high temperatures.

(5) Produce clean eggs by keeping nests and pens clean. Gather the eggs at least four times daily.

EGG QUALITY CONTROL

Eggs lose their quality if not properly cared for. Factors that contribute to the loss in quality:

(1) At **high temperatures,** interior quality is lost rapidly. Eggs should be gathered in wire baskets and cooled as quickly as possible after they are laid. Following cooling the eggs should be packed in clean Keyes trays, large end up, and held at 50° to 55°F. until they are taken to market.

(2) At higher relative humidities the rate of loss of moisture from eggs is less than when the relative humidity is low. A relative humidity of 60 to 70 percent in egg rooms is recommended.

(3) As eggs age there is loss of quality regardless of the storage conditions. For this reason eggs should be marketed twice weekly.

(4) Eggs readily take on odors: egg rooms should be free of vegetable, coal oil, musty or other odors.

(5) Rough handling may result in cracked or broken shells, loose air cells, or a decrease in interior quality, all of which cause lower grade returns.

CHICKEN HATCHING EGG PRODUCTION

In general, the feeding and management of hatching egg flocks is similar to that outlined for commercial egg flocks. Certain aspects, however, should be given additional attention.

Costs Involved in Hatching Egg Production — It costs more to produce hatching eggs than commercial eggs. The principal items of extra cost are are follows:

(1) Cost of banding and blood testing breeders.

(2) Extra cost of breeding mash as compared to laying mash.

(3) Cost of males. To the purchase price of the males less their salvage value at the end of the season, one should add the value of the eggs that a like number of pullets would have produced.

(4) Risk. Risk involved in the hatching egg business includes disease, the production rate during the hatching season, percentage hatch, and the length of hatching season.

(5) Another item is the strain or breed of bird kept. It is possible that the strain kept for hatching-egg production may not be the same as one would keep for the production of commercial eggs. The hatching egg market may demand breeds or strains that do not possess the egg laying ability, feed efficiency or livability of strains that might be kept for market egg production.

FEEDING AND MANAGEMENT OF THE HATCHING EGG FLOCK

Feeding — The hatching egg flock should be fed a breeding ration rather than a laying ration. Feeding of the breeding ration should commence about 6 weeks prior to breeding and continue throughout the breeding season. Any of the systems of feeding for laying birds may be followed; however, the best control of nutrient intake is obtained by the all-mash method.

Fertility — In order to obtain a high percentage hatch, good fertility is necessary. Strong vigorous cockerels should be used, and care should be exercised that they do not get their combs frozen; this will result in low fertility. In flock matings, one male for 12 to 15 females in the case of heavy breeds, and one male for 15 to 18 females in light breeds, is adequate.

The males should be placed in the pens about ten days before collecting eggs for hatching. They may be removed a week before the end of the hatching season without loss of fertility.

Care of hatching eggs — Hatching eggs should be handled in much the same manner as market eggs. The main points to be observed are:

(1) Collect eggs four times daiily and cool quickly to 50° to 55°F.

(2) Do not wash hatching eggs unless by a proper egg washing machine. Follow manufacturer's direction. Dirty eggs may also be cleaned with sandpaper or fine steel wool.

(3) Only sound shelled eggs of suitable size, shape, and shell quality should be shipped to hatcheries. The eggs should be packed large end up in clean Keyes trays.

(4) Hold hatching eggs at 50° to 55°F. Avoid chilling or overheating since these result in lowered hatchability.

(5) Shipment to the hatchery should be made twice weekly and eggs should be protected against extremes of temperature during shipment.

(6) Rough handling of hatching eggs results in lowered hatchability.

BROILER PRODUCTION

Size of enterprise — It is generally considered that marketing of 50,000 or more broilers a year is necessary to ensure a satisfactory income from broiler raising.

Type of operation — Broilers are marketed at 8 to 10 weeks of age at an average weight of 3 to 3½ pounds. Usually they are raised in groups of 5,000 to 10,000 with four or five marketings a year. This permits a thorough cleaning of the premises between each batch of broilers and prevents disease better than the continuous type of operation where a new lot of broiler chicks is started each week. The latter system, however, yields a more regular supply, which may be desirable under certain circumstances.

Broiler chicks — A white broiler is preferred. The majority of broiler chicks sold today come from crosses involving dominant white Cornish-type males mated to meat type females. The latter consist largely of special meat strains of White Rocks and New Hampshires. Chicks of this type, under proper feeding and management, are capable of averaging three pounds in weight at nine weeks of age with a

feed requirement of 2.5 pounds of feed per pound of gain.

Housing and equipment — Broiler houses are generally of the permanent brooder house type, one square foot of floor space being provided for each broiler. Houses should be force ventilated, equipped with mechanical and/or hanging feeders, automatic waterers and, of course, with brooders. Some auxiliary heat also is necessary to facilitate the maintenance of proper temperatures, 65° to 70°F., in the house.

Brooding — See details under brooding for commercial egg production.

Feeding — Broiler chicks should be fed a high energy broiler ration containing approximately 22% protein until they are 6 or 7 weeks of age and a high energy finishing ration containing approximately 19% protein until they are ready for market.

TURKEY GROWING

Size of enterprise — It is generally considered that 5,000 or more turkeys must be raised to ensure an adequate income from turkey growing.

Type of operation — Turkeys are usually raised on open range, however, recently some growers have adopted confinement rearing in sheds. Under the rotational range system one acre should be provided for each 100 to 200 turkeys raised; in the confinement method 4 to 6 square feet of floor space is provided for each turkey.

Type of poult — The Broad Breasted Bronze turkey is preferred by most growers, however, recently growers have shown interest in Broad Breasted Whites. Where a specialized market exists for a small type turkey the Beltsville White may be found more suitable.

Housing and equipment — The brooding accommodation and equipment required is similar to that required for large scale chicken brooding. Range shelters may be of cheaper construction than for chickens since all that is needed is protection from wind and storms. Range equipment should consist of large self-feeders, automatic waterers and low movable roosts made from two-by-fours, flatwise, spaced about two feet.

Brooding and rearing — See details under brooding and reading of chicks for commercial egg production.

Feeding — Poults should be started on a 28 to 30% protein, high energy vitamin fortified starter for ten days. They should then be transferred to a 26% protein starter until they are 8 weeks old at which time they should be fed an 18 to 20% protein growing feed in mash or pellet form plus whole grain. As an alternative, growing concentrate in mash or pellet form plus whole grain may be fed. As soon as the feeding of whole grain is commenced the birds should have access to oyster shell and insoluble grit. Four to six weeks prior to marketing the turkeys should be fed a 13 to 14% protein, high energy fattening mash as the sole feed. It takes approximately 100 pounds of feed to raise a turkey to market age.

Marketing — Females are generally marketed when they are 24 to 26 weeks old and toms at 28 to 30 weeks old.

TURKEY BROILER PRODUCTION

For turkey broilers a small white turkey such as the Beltsville White is preferred. The principles involved in brooding, rearing and feeding are similar to those outlined above. About three square feet of floor space per bird is required for confinement rearing. Turkey broilers are generally sold at 12 to 16 weeks of age weighing from 10 to 12 pounds.

TURKEY HATCHING EGG PRODUCTION

For this purpose poults are brooded and reared in much the same manner as outlined under Turkey Growing. Prospective breeders should be selected when 20 to 22 weeks of age. From this time until the birds are placed in the breeding pens the prospective breeders should be maintained on a low energy type ration. Four to six weeks before mating, the toms should be subjected to 12 to 14 hours of light to be sexually active when they are placed with the hens. From this time on both toms and hens receive light. When the pens are mated the birds should be placed on a breeding ration and be fed oyster shell and insoluble grit free choice. Any of the systems of feeding referred to under the feeding of laying birds may be followed; however, the best control of nutrient intake is obtained by following the all-mash method. If fertility is low, artificial insemination is recommended. Broodies should be placed in a broody coop as soon as detected and left there for 3 to 5 days to break them to the habit. While in the broody coop feed the regular ration. Eggs should be collected and handled in much the same way as outlined under Chicken Hatching Egg Production.

References:

Dept. of Agriculture, Edmonton
Plans for Laying Houses.
Poultry Plans Catalog.
Pub. 55—Two Whitewash formulae.
Pub. 133—Broiler Production.
Pub. 1—Turkeys.
Pub. 56—Brooding and Rearing Chicks and Poults.

Livestock Diseases and Pests

VETERINARY SERVICES BRANCH, ALBERTA DEPT. OF AGRICULTURE

This Branch, under the Director of Veterinary Services, offers various services to the Alberta livestock producer. It is primarily concerned with maintaining and promoting the health of all classes of livestock and to reduce the disease loss. The control and eradication of diseases named in the Animal Contagious Diseases Act is the responsibility of the Government of Canada, although provincial authorities do aid in the servicing of federal disease control programs.

Livestock Diseases Act

This Act makes possible legislation and specific disease control programs which are designed to reduce the economic loss from disease. The following programs operate under this Act:

(1) **Brucellosis Restricted Areas** — financial grants to promote compulsory calfhood vaccination and blood testing of cattle at sales. The incidence of brucellosis has been greatly reduced and the movement of infected or carrier cows curtailed. Private veterinary practitioners carry out all blood testing and vaccinating. It will be eventually replaced by the Federal Brucellosis Control Program with the test and slaughter of all infected cows.

(2) **Veterinary Inspection of Auction Markets** —Veterinary inspection is maintained at all major auction markets to prevent the selling of diseased animals which might represent a hazard to the purchaser's livestock.

(3) **Permits**—issued for poultry disease vaccines and injectable veterinary biologics.

(b) **Veterinary Laboratory**

This is a large diagnostic service laboratory located at Edmonton providing for the accurate diagnosis of disease. It makes possible the ready recognition of new diseases, the study and development of treatment and preventative measures. The laboratory services are free to all Alberta livestock producers. The majority of the material is submitted by practising veterinarians, who use the facilities to provide a better and complete service for their clients.

(c) **Extension Activities**

All available media for the dissemination of disease control information is used to keep producers informed of recent developments. These include lectures at the University of Alberta and the Schools of Agriculture. Bulletins on special diseases are prepared for free distribution.

VETERINARY PRACTITIONERS

The Veterinary Services Branch is concerned with the overall disease situation in Alberta. The veterinary practitioner is more intimately concerned with the problems on the individual premises, and the treatment of individual animals. He is familiar with the problems that exist within specific areas. Without his cooperation neither Federal nor Provincial disease control programs could operate. It is in the livestock producer's own interest to first make use of the services provided by the veterinary practitioner who will report to the Federal or Provincial Departments when necessary.

HEALTH OF ANIMALS DIVISION, FEDERAL DEPT. OF AGRICULTURE

An outline of duties and offices appears on page 145.

The following disease tables provide a summary of the important disease conditions commonly encountered in Alberta. It is impossible to list all diseases. For example, approximately 200 different disease conditions are diagnosed in Alberta poultry yearly. Therefore, a veterinarian should be consulted as satisfactory treatment depends on an early accurate diagnosis.

DISEASES OF SWINE

DISEASE	DESCRIPTION	PREVENTION AND CONTROL
Losses in Suckling pigs	Greatest loss in first 4 weeks of life. Infectious disease is responsible for only a small part of loss. Vitamin and iodine deficiency in ration of pregnant sows, anemia, chilling from damp, drafty farrowing pens, poor sanitation all are important.	Follow recommended feeding and management practices for pregnant and nursing sows. Commercial preparations containing vitamin and antibiotics are available for the control of uncomplicated scours in nursing pigs. If losses occur despite good practices seek professional help.

DISEASES OF SWINE

DISEASES	DESCRIPTION	PREVENTION AND CONTROL
Anemia	Nursing pigs receive insufficient iron from sow's milk. If iron is not available nutritional anemia will develop, causing weak, pale, listless pigs, often accompanied by scours, heavy breathing, and death.	Iron must be administered commenc- at the 2nd or 3rd day of life, repeated twice weekly for the first 3 weeks; this has been found preferable in Alberta to 7 day intervals. Preparations available are reduced iron, paste pills, liquids, ferrous sulphate sprinkled on sods, and injectable iron.
Enteritis (Scours)	In animals 4-12 weeks of age. Diarrhoea may be a symptom but loss of weight and unthriftiness are characteristic. May be the result of infection but most often origin is in poor feeding practices, high fibre rations (oats hulls) and often complicated with heavy roundworm infestation.	Laxative of raw linseed oil (¼ cupful/ 100 lbs. of pig) and light diet gradually return to full feed. Antibiotic supplements helpful but not a substitute for good sanitation. Some cases necessary to resort to medicinal treatment with antibiotics or sulfonamides.
Roundworms	Most critical in small pigs. Adult in intestinal tract produces thousands of eggs which pass out in droppings contaminating pastures, yards and farrowing pens. Eaten by little pigs, hatch, grow to maturity after passing through liver and lungs. Unthriftiness and coughing are prominent symptoms.	Good sanitary practices, including pasture rotation yearly, worm free sows and clean farrowing pens essential. Practice routine worming program at 8 weeks of age with sodium floride, cadmium preparations or piperazine. Feed additives for parasite control are being developed; see swine production page 123 for directions re sodium fluoride and sanitation principles.
Erysipelas	Most serious infectious disease of swine. Observed most frequently in pigs over 100 lbs. but will affect all ages throughout the year. Three types, acute, chronic and diamond skin disease. The acute appears suddenly with high fever, pigs prostrate and dying; spreads rapidly. Chronic type is characterized by enlarged joints, crippling and unthriftiness.	Early recognition and prompt treatment essential in acute outbreaks. Consult your veterinarian. Penicillin and erysipelas antiserum used in treatment with serum being administered to all exposed pigs; routine vaccination at 8 weeks with erysipelas bacterin from May to October at least.
Virus Pneumonia	Virus disease characterized by persistent coughing and varying degrees of unthriftiness. Most important in that it may result in severe secondary pneumonia precipitated by improperly ventilated quarters.	No effective treatment available. Good housing particularly for young pigs will control losses. Vaccination may be helpful where secondary pneumonias are a recurring problem.
Rhinitis	Infectious disease appearing first in nursing pigs causing sneezing, occasional bleeding from the nose with the gradual development of deformed, twisted or shortened snouts. Not all pigs of a litter may be affected but all are potential carriers. May affect a large number of pigs but becomes chronic with fewer animals showing symptoms.	No curative treatment. Care in purchase of stock, only from rhinitis free premises. In majority of cases it is necessary to market all pigs and start again with clean breeding stock.

DISEASES OF SWINE

DISEASES	DESCRIPTION	PREVENTION AND CONTROL
Pneumonia	Infectious disease, most frequent in colder seasons of the year, with fever, rapid breathing and varying number of animals affected.	Sick pigs isolated and treated with antibiotics or sulfonamides; avoid damp quarters; vaccination with pneumonia bacterin an aid in control.
Glasser's (Infectious) (Serostiis)	Infectious disease not completely understood. Frequently observed as a disease in litters, vigorous to 3 weeks of age at which time they begin to do poorly. Coughing, a few enlarged joints, heavy breathing and stunted growth in survivors is characteristic.	Terramycin and some other antibiotics are successful treatment. It is best to consult your veterinarian since it is necessary to follow management practices designed to eliminate or control the infection.

DISEASES OF CATTLE

Vitamin A Deficiency	Deficiency observed as weak calves, scours, convulsions and death; blindness and collapse in feed lots.	Adequate amounts of vitamin A in ration of pregnant cows; good quality roughage. The use of commercial vitamin A supplements (to supply 30,000 I.U. vitamin A daily) for pregnant cows and feedlot animals can be highly recommended.
Mineral Deficiency	Commonly observed in Alberta, particularly phosphorus deficiency in cows with depraved appetite, loss of condition and breeding deficiencies.	Mineral supplements must be used. Expensive complex preparations are not necessary — Don't forget salt.
Calf Scours	**Beef** — almost invariably related to vitamin A deficiency. **Dairy** — vitamin A is important but infection from contaminated surroundings and improper management practices are factors; will establish itself as a highly infectious disease in a herd.	Follow recognized feeding and management practices; good sanitation in dairy barns. Commercial calf scours preparations (containing antibiotics and sulfa drugs) are available. Vitamin A is helpful in treatment.
Bloody Diarrohea Coccidiosis	Infectious disease observed most frequently in young beef animals in colder seasons of the year characterized by bloody diarrohea.	Suspected diagnosis should be confirmed; sulfonamides or intestinal astringents are used in treatment.
Indigestion	An acute toxemia with depression — coma and death; result of a sudden change of feed, switch to new grain, animals gaining access to open bins or granary. In severely affected animals the outcome is almost always fatal.	Try to avoid circumstances which cause it. Get professional help. The administration of oil, forced exercise and restricted water intake may be helpful.
Bloat	**Acute** — rapidly developing fatal bloat occurring on lush pasture, particularly legumes. **Chronic** — observed most often in individual beef animals; not usually immediately fatal. There is still much unknown concerning the true cause of bloat.	Avoid turning hungry cattle on to young lush legume pasture particularly if it is wet. Kerosene in milk, the placing of a gag in the mouth or puncturing the rumen (right side) with trocar and canuala in acute cases; treatment of chronic bloat not often successful

DISEASES OF CATTLE

DISEASES	DESCRIPTION	PREVENTION AND CONTROL
Blackleg	Acute infectious disease of young cattle between ages of 4 months to 2 years; occurs most frequently on pasture but may occur throughout year in animals of all ages. Animals often found dead, carcass bloated; gassy swellings underneath the skin are often a prominent feature.	Vaccinate calves and yearlings routinely with blackleg-malignant oedema bacterin. Calves should be 4 months of age if good protection is to be afforded.
Malignant Oedema	Very similar to Blackleg.	As for Blackleg.
Clostridium Perfringens	Not completely understood; disease entity very similar to Blackleg. May cause sudden losses in nursing calves, scours and convulsions; not to be confused with vitamin A deficiency.	Professional help is required for accurate diagnosis—Perfringens bacterins are successful in control; antitoxins for treatment.
Shipping Fever	An acute suddenly occurring infectious disease of beef cattle usually associated with shipping. High fever, pneumonia, sometimes scours are characteristic.	Try to avoid rough handling. The use of vaccines two weeks prior to shipping may be helpful. Obtain qualified advice in the handling of outbreaks.
Mastitis	Infection of udder of dairy cows with development of flakes, clots and blood in milk; acute flare-ups on occasion with swollen udder. Irritation and damage to udder is a factor in cause.	Follow milking practices and management designed to control mastitis. Early treatment is essential. Don't waste money on repeated treatment of individual cows. Mastitis control programs are available through your veterinarian.
Brucellosis	Infectious disease, causing abortion sterility, retained afterbirth, and transmissible to man. Infected cow main spreader.	Calfhood vaccination, blood testing and elimination of infected cows. Control programs sponsored by both Federal and Provincial Governments.
Vibriosis	Infectious disease characterized by early abortion and repeated breedings. Cows recover but the infected bull, the main spreader, remains so indefinitely.	Must be diagnosed by a veterinarian. Elimination of infected bulls; use clean bulls on clean cows — Herd control programs are successful.
Cancer Eye	White faced cattle, small sore on eyelid which will continue to grow until animal dies or is killed.	No treatment, early salvage by slaughter. Surgery may be successfully performed on valuable animals.

DISEASE OF SHEEP

Stiff lamb disease	Nutritional disease in lambs 3-10 weeks of age, particularly in early lambs; stiffness of hind-quarters developing into paralysis and inability to stand; while exact cause is unknown believed to be nutritional in origin with restricted exercise a possible factor.	Administration of a teaspoonful of 10% phosphoric acid daily in milk is effective treatment. Vitamin E supplements are believed to be helpful in preventing the condition.

DISEASE OF SHEEP

DISEASES	DESCRIPTION	PREVENTION AND CONTROL
Weak Lambs Scours	Losses occur in new born lambs, diarrohea, weakness, and death; are not the result of infectious disease but of nutritional deficiencies, particularly vitamin A in ration of ewes during pregnancy.	Follow recommended feeding and management practices for pregnant ewes. Vitamin A supplements can be recommended; concentrated fish oil administered to weak lambs at birth.
Clostridium Infection (new born lambs)	Infectious disease appearing as yellow pasty diorrohea with rapid death and losses occurring despite good feeding and management practices.	The disease should be confirmed by consulting a veterinarian. The vaccination of pregnant ewes with a Type D clostridium perfringens bacterin is indicated. The bacterin and antitoxin can be administered to lambs if indicated.
Internal Parasites Roundworms	Sheep are highly susceptible to a number of types of roundworms, all are serious parasites; in lambs the blood sucking stomach worm will cause heavy death loss; intestinal worms causing diarrohea and loss of appetite are often observed.	Follow a regular parasite control program; worm flock in January; repeat in early summer and fall. Phenothiazine is most popular treatment and can be mixed with salt for continuous administration.
Lungworms	Parasite that lives in lungs resulting in persistent coughing, unthriftiness, and death.	Treatment with commercial lungworm preparations — good sanitation important.
Tapeworms	Not as serious as roundworms; may cause symptoms of incoordination or staggering.	Require special treatment; phenothiazine is not effective; excellent commercial preparations available.
Entero-toxemia (Clostridium Perfringens)	Infectious disease observed most frequently in lambs on heavy feed; suddenly appearing convulsions, spasms and death; may occur in nursing lambs.	Good practice to vaccinate feeder lambs with a Clostridium perfringens type D bacterin routinely.

DISEASES OF POULTRY

List of Eight Important Diseases of Poultry in Alberta

Leukosis Complex	A virus tumour type of infectious disease showing up in various forms, e.g. paralysis, enlarged livers, bones, etc.; spread by direct contact, aerosols and egg transmission; affects chickens mostly but can affect turkeys.	Control difficult — raising day-old birds at least 200 yards from old birds assists in reducing incidence.
Avian Tuberculosis	A bacterial infection similar to cattle and human types of tuberculosis; not highly transmissible to people, but highly transmissible to pigs; affects chickens and turkeys.	Sanitary management; no drug treatment effective.
Infectious Bronchitis	A rapidly spreading virus infection of lungs and windpipe of chickens; does not affect turkeys; can cause losses in baby chicks; in adults loss of egg production.	Vaccinate chicks; revaccinate birds producing hatching eggs to ensure temporary parental immunity to offspring.

DISEASES OF POULTRY

DISEASES	DESCRIPTION	PREVENTION AND CONTROL
Coccidiosis	An intestinal disease caused by tiny microscopic protozoan parasites called coccidia. These breakdown the cells of different parts of the intestinal tract; different types affect different areas. Both chickens and turkeys can "get" coccidiosis but the chicken form does not affect turkeys and vice versa.	Maintain litter and surrounding of birds in a dry condition; the use of commercial coccidiostat in the feed or water recommended; several good drugs available for treatment; follow manufacturer's instructions.
Chronic Respiratory Disease	A chronic slow spreading infection of lungs, windpipe and air sacs in chickens; also cause swollen sinuses of the face in turkeys. Caused by a microscopic organism called P.P.L.O. possibly with a virus assisting it. Very chronic in nature, "handing on" in a flock through the life of the birds. Sometimes noticeable as a sneeze or cough and low egg production; may cause fairly high losses in broilers; transmission from bird to bird or through eggs.	None really effective to date. Administration of antibiotics assist in "holding down" symptoms but generally do not cure it; much hope held for the production of P.P.L.O.-free breeding flocks.
Entero-hepatitis (Blackhead)	A highly fatal liver and intestinal infection of turkeys and chickens caused by tiny microscopic protozoan parasites called Histomonads. These generally infect by "hiding" in the body and eggs of the common caecal worm of chickens. Chickens have some resistance but turkeys are highly susceptible.	Do not raise chickens and turkeys together. Proper range rotation to eliminate worm eggs. Attempt control by drugs fed continually in the feed; this is still very expensive; good drugs available for treatment.
Fowl Typhoid	A serious bacterial infection of poultry (chickens, turkeys, ducks, geese, etc.); generally associated with poor sanitation; mostly affects adult birds. Transmission is by direct contact carrying infected manure from farm to farm; or through eggs; in Alberta has been confined to the area east of Edmonton.	Good poultry sanitation; rotate ranges, keep birds away from their droppings; use clean disinfected laying houses; good roosts and dropping board construction. Restock with day-old chicks only from approved hatchery; drugs available for treatment.
Pullorum	A generalized bacterial infection killing mostly baby chicks and poults; transmitted by direct contact or through the eggs.	A continent-wide blood testing program has greatly reduced the incidence. Restock with only day-old chicks from an approved hatchery where all eggs are set from pullorum and Fowl Typhoid tested birds; drugs available for treatment.

POISONINGS

A considerable number of cattle, swine and other livestock are lost each year. Many such losses can be avoided if potential dangers are recognized and known harmful substances properly handled. In most cases healthy animals will sicken or die suddenly with no observable period of illness. Diagnosis is established by the demonstration of the poison in the stomach and organs of the animals. A veterinarian should perform the post-mortem in order that specific changes may be noted and proper material is collected. This is most important if there is a possibility of damage claims. The commonly encountered poisons are listed below.

(a) **Plants** —usually when normal forage is in short supply; — water hemlock, larkspur, algae (water scum) death camas, loco weed, nitrate poisoning (oat hay).

(b) **Chemicals** —lead, arsenic, sodium chlorate, mercury, nitrates. Agricultural chemicals, including insect sprays, some weed sprays, some wood preservatives, and livestock sprays are dangerous if used carelessly.

(c) **Waters** —chemically unsuitable waters do not often cause death but they will seriously affect the health of animals. The presence of the following substances in amounts indicated and greater are unsuitable:—

Sodium chloride (salt)	50 grains per gal.
Sodium sulfate (Glaubers salts)	100 grains per gal.
Magnesium sulfate (epsom salts)	100 grains per gal.
Sodium carbonate (soda)	100 grains per gal.
Iron	0.3 parts per million
Nitrates	5.0 parts per million

Water supplies can be checked by submitting a sample in a clean sealer to the Veterinary Laboratory. There is no charge.

PREVENTING LIVESTOCK LOSSES

Practical points of livestock production which are important in preventing disease losses.

SWINE

1. Care in purchase of breeding stock. Buy only from disease-free premises.
2. Follow accepted practices in feeding and management of pregnant sows.
3. Provide farrowing quarters that avoid draughts and dampness in the colder seasons of the year and which can be readily cleaned and disinfected.
4. Creep feed and starter rations are important.
5. Follow a routine worming program, combined with good sanitation and pasture rotation.
6. Innoculate routinely with erysipelas bacterin at 8 weeks of age, particularly from May to October.

DAIRY CATTLE

1. Calfhood vaccination for control of Brucellosis.
2. Good management practices as applied to the feeding and housing of calves.
3. Follow a program designed to prevent and control mastitis. Good sanitary milking practices, udder care, the routine use of a strip cup, and a sponsored mastitis control program if indicated.
4. Innoculation of calves and yearlings with Blackleg, Malignant oedema bacterin before pasture season.

BEEF CATTLE

1. Calfhood vaccinations for Brucellosis control.
2. The supplementation of diet of pregnant cows with vitamin A and mineral to ensure a healthy calf.
3. The innoculation of calves at branding and weaning and yearlings with Blackleg, Malignant oedema bacterin.
4. Animals going into feed lots should be revaccinated for Blackleg and Malignant oedema and probably Clostridium perfringens Type D.
5. A pasteurella (pneumonia) bacterin can be used in the fall as additional protection against pneumonia.
6. Mineral supplements to pasture cattle will eliminate some of the commonly occurring sterility problems.

SHEEP

1. Adequate feeding of pregnant ewes with vitamin supplements to ensure healthy lambs.
2. Follow a routine worming program, with administration of phenothiazine in January, early summer and fall.
3. Innoculate feeder lambs with Perfringens Type D Bacterin.

POULTRY

Do

1. Purchase day-old chicks or poults from an approved hatchery.
2. Brood chicks or poults in clean, disinfected brooder house.
3. Feed chicks only a good commercial or recommended chick starter. Feed poults only a good commercial or recommended turkey starter. No other feed should be necessary until the birds are six to eight weeks old, then give growing mash (see feeding).
4. Put birds onto good green range when ready. Fresh range should be used each year (see Range Rotation). Range should be well away from barn yard.
5. In the fall bring hens into clean, disinfected laying house.
6. Keep litter in hen house dry.
7. Use proper roosts and screen off droppings under roosts.
8. Use sanitary feed and water troughs — with covers or spinners on top to prevent droppings getting in with feed and water.
9. Raise feed and water troughs at least one foot off the floor.
10. Bury all dead birds or throw in toilet.
11. Fill in all low or damp spots on the range or fence them off.
12. Control lice — with nicotine sulphate painted on roost (8 ounces per 100 feet).
13. Control mites — with lindane; D.D.T.; or Kerosene and crank case oil.
14. Sell off the old flock in the spring, after peak egg production is over — and clean and disinfect the hen house.
15. If you have birds die — find out why! See your veterinarian.
16. Check on your management. See your Poultry Inspector or District Agriculturist.

Don't

1. Don't run chickens and turkeys together as it's only a matter of time before you run into trouble.
2. Don't run poultry and pigs together — keep them all separate as they can get disease from one another, especially tuberculosis.
3. Don't throw dead birds to the pigs.
4. Don't throw dead birds on manure piles— bury them.
5. Don't let poultry get onto the manure piles.
6. Don't overcrowd birds. Allow four square feet of space for each hen.
7. Don't let poultry run all over the barnyard. Have a place for them and keep them there.
8. Don't fertilize poultry or hog ranges with poultry manure.
9. Don't let visitors into your poultry pens and yards unless they wear clean rubber boots.
10. Don't feed grain on the floor or ground.
11. Don't bring dirty crates or equipment into your farm.
12. Don't go into a neighbour's poultry pen— especially if he has sick birds. If you must — disinfect your shoes or boots before you go to your own flock.
13. Don't feed birds the insides of dressed chickens or turkeys.

HEALTH OF ANIMALS BRANCH, FEDERAL DEPARTMENT OF AGRICULTURE

Calgary Sub-district office - - - -	407 Public Building, Calgary
Camrose Sub-district office - - - -	Post Office Building, Camrose
Coutts Sub-district office - - - - -	Customs Building, Coutts
Drumheller Sub-district office - - -	Post Office Building, Drumheller
Edmonton Sub-district office - - - -	761 Federal Building, Edmonton
Lethbridge Sub-district office - - -	401 Post Office Building, Lethbridge
Medicine Hat Sub-district office - - -	Post Office Building, Medicine Hat
Peace River Sub-district office - - -	Post Office Building, Peace River
Red Deer Sub-district office - - - -	217 Public Building, Red Deer
Vermilion Sub-district office - - - -	Heckbert Building, Vermilion
Wetaskiwin Sub-district office - - -	Bank of Montreal Building, Wetaskiwin

District Office — 403 Public Building, Calgary, Alberta

This Division conducts tuberculosis tests of cattle under the Accredited Herd Plan and Restricted Area Plan; conducts Brucellosis tests under Brucellosis-Free Herd Policy and Brucellosis Control Program; export and import inspections of livestock to and from foreign countries; investigations and control of reportable diseases under the Animal Contagious Diseases Act and Regulations; meat inspection service under the Meat and Canned Foods Act; takes action on reportable diseases listed.

SOME REPORTABLE DISEASES IN ALBERTA

DISEASE	SPECIES AFFECTED, CAUSE AND SYMPTOMS
Mange (Scab)	A parasite (mite) infestation of horses, cattle and sheep; excessive itchiness, loss of hair or wool.
Anthrax	A bacterial infection of horses, cattle, etc.; swelling of throat or other parts; temperature rise; blood from nose or mouth; usually quick death.
Foot and Mouth Disease	A virus infection of cattle, sheep and swine; vesicles (blisters) on tongue, lips, gums, muzzle, between claws of feet, sometimes teats or udder; abortion; highly contagious; epidemic in some foreign countries.
Rinderpest	A virus infection of ruminants, particularly cattle; inflammation mucous membranes; erosions in mouth; diarrhea, may be blood stained; severe straining; highly contagious; epidemic in some foreign countries.
Hog Cholera	A virus infection of hogs; high fever, off feed, disinclined to move, weakness, blueness of ears, abdomen, legs; diarrhea; pregnant sows abort.
Scrapie	A virus infection of sheep and goats; restlessness; excitable, shivering, grinding of teeth, itchiness first noticed over kidney region, scratching itchy spots causes tremor or smacking of lips, finally animal weakens, stupid, falls down, emaciation.
Newcastle Disease	A virus infection of chickens and other poultry; respiratory and nervous symptoms; gasping; partial or complete paralysis; walking in circles, head held in unnatural position; laying birds show drop in egg production, shell texture may be poor.

Others: — Glanders, Dourine, Contagious Pleuro-Pneumonia, Texas Fever, Rabbies, Fowl Typhoid, Vesicular Exanthema of Swine.

Action: — If any of above diseases suspected, contact nearest sub-district veterinarian (as listed) or a veterinary practitioner who is required by law to report to Federal authorities.

APPLYING INSECTICIDES TO CONTROL LIVESTOCK INSECTS

Modern insecticides, properly used, will control most insects attacking livestock. Insect control will increase weight gains, grade of carcass, milk flow, and health of animals generally. It is essential for profitable livestock production in small farm herds as well as large ranch herds.

Satisfactory control can be obtained in small herds by farmers without costly equipment. Community action is recommended to control houseflies and warble flies.

For insect control in large herds, power equipment is essential.

Sprayers, to be suitable for livestock insect control, must: (1) be capable of maintaining any pressure up to 500 pounds per square inch, and be able to deliver at least four gallons per minute; (2) be equipped with a mechanical agitator in the tank, and adequate strainer between the tank and the pump, and suitable drain cocks for draining pump and tank.

High pressures are necessary for livestock insecticides to penetrate the hair. The chemical must reach the skin to control warbles and lice, and break down the scab to control warbles with rotenone. Universal type sprayers are most suitable and are available at reasonable cost.

When using wettable powders in spray machines, special precautions should be taken to see that the pump is thoroughly washed after each use. Such materials should never be left in the tanks over night.

Single nozzle adjustable spray guns are most satisfactory for warble fly control. Triple nozzle spray guns are most suitable for spraying animals for louse control, barns and other buildings for fly control, and farmsteads for mosquito control. Fan-type guns can be used for warbles, lice, and other livestock insect control work particularly in the use of Co-Ral. Most multiple nozzle and fan type guns are not adjustable.

Self applicators (back rubbers) for applying chemicals to livestock are very satisfactory for control of horn flies. They are of doubtful value in the control of other biting flies (horse flies, deer flies, mosquitoes, black flies, etc.)

and lice. They have no value in the control of warbles.

Suitable applicators may be cheaply made with materials available on any farm. Several strands of barbed wire may be loosely twisted together and wrapped with old sacking, until a roll about six inches in diameter has been completed. This is then tied tightly every four to six inches with heavy cord. This roll may be attached to two posts placed a rod apart. It should be fastened four to five feet above the ground at the posts, and allowed to sag within a foot of the ground in the centre. It should be soaked with a five percent solution of DDT or methoxychlor in a suitable solvent. (Solutions suitable for use with applicators can be secured from most chemical companies.) Solutions containing DDT should not be used (where the rubber is) for dairy cattle. This applicator will require about one to 1½ gallons of mixture. It will be necessary to moisten it with additional chemical at about weekly intervals. Repairs can be made with additional old sacking and cord. There are many other ways of making such a roll and other methods of attachment to posts. Any method which provides a suitable absorbent roll and allows the animals to treat themselves is satisfactory. The rubber should be located near the water supply or salt block or any area where cattle loaf.

Sanitation—Failure of insecticides to control certain insects, particularly houseflies and stableflies, is often blamed on resistance of the insects to the insecticides. Such failures nearly always occur because of lack of sanitation and not because the insects have become resistant to the insecticide. If manure, litter, and other breeding places are not cleaned up the insects may appear in too large numbers for insecticides to control.

SANITATION IS ESSENTIAL

Livestock should not be fed on insecticide-treated plants until danger from poison residues is past. The required interval between treating the plants and pasturing or cutting them for feed is as follows: aldrin, 2 weeks; heptachlor, 3 weeks; chlordane, dieldrin, D.D.T., and toxaphene, 1 month.

IF POISONING OF LIVESTOCK BY INSECTICIDES IS SUSPECTED CALL A VETERINARIAN

Symptoms are in general similar for most animals. They are: nervousness, wild stare, tremor, slobbering, diarrhoea, loss of appetite and weight, paralysis and convulsions. Animals in poor condition are more susceptible to poisoning by livestock sprays than those in good condition.

SYMPTOMS OF POISONING

By Dieldrin, Aldrin, Hepatchlor, Chlordane, Lindane (BHC), DDT, and Toxaphene

Symptoms of poisoning may appear in as little as 15 minutes and usually within 24 hours after exposure.

An affected animal will generally first become excitable and more alert to its surroundings. Twitches of various muscles follow, usually beginning at the head and moving back along the body. The twitches may increase in intensity until there are spasms and finally convulsions.

The animal may also assume abnormal attitudes, such as standing with the head between the forelegs and under the body or in a sternal position.

There may be persistent chewing movements. Occasionally the animal attacks any moving object. Usually there is profuse salivation, dyspnea (difficult breathing), rolling of the eyes, dribbling of urine, and bawling. The body temperature often reaches 114-116 degrees F.

Some animals show none of these active symptoms. Instead, they become depressed and unaware of their surroundings. Others are alternately depressed and excited.

Severity of symptoms is no index of the likelihood of death or survival. Death may occur in less than an hour — or several weeks after exposure. Most cases run their course within 72 hours.

SYMPTOMS OF POISONING

By Parathion, Eph, Malathion, Dipterex (Dylox), Chlorthion, Dow ET-57 (Trolene), and Bayer 21/199 (Co-ral)

Poisoned animals generally first show excessive salivation. The flow is abundant, and the consistency of the saliva approaches that of water. The animal then usually encounters respiratory difficulty and breathes with the mouth open and with generally exaggerated respiratory movements. As the respiratory effort increases, the animal walks stiff-legged and wanders about restlessly. Rippling spasms of all body muscles are present. Eventually exhaustion forces the animal to lie down. As death approaches, there are rasping sounds from the lungs and the animal grunts softly with each breath. Death appears to occur by respiratory failure. With the very high doses convulsions have been seen.

INSECT PESTS OF LIVESTOCK AND POULTRY

INSECT	NATURE OF DAMAGE	CONTROL
Lice (of cattle)	Biting lice feed on skin surface and irritate animals. Sucking "blue" lice, common in winter, suck blood, reduce milk yields and weight gains, cause rash, severe irritation and anemia. Lousy animals get thin and may die. Lice begin to show up in the fall as dark patches where the hair is thin, particularly along the underline. A lousy animal has greasy patches of hair and an odor of stale blood. Eventually the hair is rubbed off in patches.	Wash, dust or spray (at 400 pounds pressure using No. 4 discs or T jets of similar capacity) with 50% emulsifiable malathion, lindane, methoxychlor, rotenone, (warble powder), toxaphene, or DDT. Use wettable powders, emulsible concentrates or dusts. Treat once with malathion, twice with other recommended chemicals 12-14 days apart. (For dairy cattle or animals within one month of slaughter use only rotenone or methoxychlor.) Chemical must reach skin. Fall treatment is best. Where cold weather treatment is required, use a dust. When spraying for lice the operator should attempt to hold the gun within 12 inches of the animal's body.
Cattle Warbles (Heel flies or gadflies)	Warble flies worry and frighten animals when laying eggs on legs and lower part of body. This causes gadding which reduces milk yields and weight gains. Grubs in animals reduce milk and meat yields and carcass grades, and cause unthriftiness, and injury to hides. Contrary to general belief, warble flies cannot bite or sting.	Community action is recommended but single-farm control can be effective. Treat with special warble powder. Time: Begin in early March, or when holes in hides are about as big around as lead pencil. Treat at 30-40 day intervals as long as live grubs are present. Method: (a) in small herds and dairy cattle, scrub the wash over backs of cattle with a stiff brush or rub powder well into holes, (b) in large herds use a power sprayer at 400-500 pounds pressure, using a single nozzle gun with 5/64 inch opening. Hold gun 18-20 inches above the back and limit the size of cone of spray to 4-6 inches. Use powder prepared especially for power sprayers. Use one half to one gallon per animal.
Houseflies	The house fly carries and spreads diseases and parasitic worms of man and animals. The maggots are found in manure, garbage, and other decaying materials.	Sanitation is essential. Clean up breeding places in barns, feed-lots, garbage, and privies. Treat privies with chloride of lime. Spray manure piles with malathion. Spray interior and exterior of barns, chicken houses, privies, etc., with DDT, methoxychlor, lindane, or malathion. Household residual sprays or pyrenone space sprays are available. Poison baits may be used. If a power sprayer is used limit the disc opening to 4/64 inches.

INSECT PESTS OF LIVESTOCK AND POULTRY

INSECT	NATURE OF DAMAGE	CONTROL
Cattle Warbles (Heel flies or gadflies)		Two Systemic chemicals are now available for warble control. "Co-Ral" is used as a spray; "Trolene" as a bolus or drench. If these are used read carefully the recommendations and precautions on the container.
Horn flies	Irritation and loss of blood caused by small, dark grey, biting flies clustering behind the shoulders of cattle. Sometimes attack sheep and horses. Mainly July - August.	Spray backs of animals with 1 pound 50% wettable DDT or methoxychlor in 10 gallons of water or with pyrenone livestock spray or one gallon 50% emulsifiable malathion per 100 gallons. Do not use DDT on dairy cows, or on any animals within one month of slaughter. Power sprayers or back rubbers may be used for range animals.
Stable Flies	Painful bites, loss of blood. May transmit disease.	Eliminate breeding places; spread manure and wet litter, plow under stack bottoms. Spray barn interior with residual insecticide (see houseflies); spray animals as for horn flies.
Black Flies ("Sand Flies")	Feeding by small hump-backed, greyish flies on thinly-haired parts of animals, particularly cows and bulls, causes loss of blood, soreness, swellings, serious illness or death within a few hours of first mass attack late in May or in June. Milk production may be reduced. Swarms of killing species come mainly from rocky rapids of fast flowing rivers. Less dangerous, but highly troublesome species, emerge from other rivers.	Watch carefully for dangerous swarms of these flies particularly in late May and in June; as soon as any appear stable valuable animals, particularly bulls. Small swarms may occur throughout the summer. Use smudges to protect animals that cannot be stabled. Serious damage is most common within 50 miles of fast flowing rivers. Some relief may be obtained by spraying animals as for mosquitoes.
Mosquitoes	Worry and loss of blood. May transmit disease. Mosquitoes breed mainly in temporary pools in weedy roadside ditches and pasture depressions. Our species do not breed in extensive permanent sloughs nor in dugouts.	Drain breeding places in entire community, or kill larvae soon after pools form in the spring with a film of oil, with or without DDT added (1/10 to ¼ pound per acre). To kill adults use a residual spray of DDT wettable powder on vegetation and buildings to a height of 10 feet. Pyrenone livestock sprays, smudges, or commercial fly repellents will give some relief.
Horse Bots (and nose flies)	Flies annoy animals while laying eggs on lips, throat, and legs. Eggs or young grubs are swallowed and cling to wall of stomach, intestine, and anus, causing rundown condition and sometimes death. These flies cannot bite or sting.	Provide darkened shelters for pastured animals. Use nose muzzle and underjaw protection. Treatment by veterinarian with carbon bi-sulphide capsules before December 15.

INSECT PESTS OF LIVESTOCK AND POULTRY

INSECT	NATURE OF DAMAGE	CONTROL
Horse Flies (Deer flies, Bulldogs)	Painful bites, loss of blood, and unrest; gadding in cattle. May transmit disease.	Provide darkened shelters for animals. Use pyrenone livestock sprays. Fly nets or coverings may help.
Sheep Keds (miscalled sheep ticks)	Brownish, flattened, tick-like insects about ¼ inch long. Pollute fleece and reduce vitality due to loss of blood and irritation. Animals damage fleece by rubbing.	Pack sheep tightly into pens or chutes and thoroughly spray at 250 to 400 pounds pressure or dip, using lindane, toxaphene, rotenone (derris), DDT or chlordane. Derris is safe to use immediately after shearing. One week to 10 days should elapse to allow cuts to heal before other insecticides are applied.
Ticks (not to be confused with sheep keds.)	Ticks fasten themselves to most animals running on infested scrub-covered pastures and ranges, particularly in May and June; suck blood, causing weakness. May transmit diseases, such as Rocky Mountain spotted fever and tularaemia.	Destroy rodents on ranges. Keep animals off infested areas. Spray infested animals with toxaphene or lindane. Individual ticks may be picked off by hand. Mostly confined to the south of the Province.
Lice (of sheep, goats, and hogs.)	Irritation, rash, loss of hair or wool, poor condition.	Spray, dip, dust, or wash with lindane, methoxychlor, rotenone (Warble powder), toxaphene, DDT, or malathion. Treatment and precautions as for cattle lice. Rotenone is poisonous to hogs.
Lice (of poultry)	Chickens appear dopey and listless; egg production falls off.	Clean poultry house, spray with lindane or malathion, and then completely replace nest material, or spray or paint roosts with lindane or nicotine sulphate or malathion, or dust birds with rotenone or DDT dust or sodium fluoride or fluosilicate.
Mites (of poultry)	Scaly legs.	Scrub, then dip legs in equal parts of kerosene and raw linseed oil. Clean and spray chicken house as recommended for chicken lice.
	Chicken roost or red mites; suck blood at night. On roosts and walls during day.	Paint roosts or spray houses well with lindane or malathion. Ventilate well.
Mange and Scab Mites	Attack horses, cattle, swine and sheep. Irritation causes animals to rub and scratch; scabs form in advanced stages, and there is a loss of hair or wool.	When on horses, cattle, or sheep, must be reported to the Health of Animals Branch immediately. When on hogs, scrub, or spray at 350-400 pounds pressure, premises and animals with lindane using 1 pound 50% wettable powder in 100 gallons of water. Two scrubbings or sprayings are necessary at 10-12 day intervals. Clean up infested premises.

INSECT PESTS OF LIVESTOCK AND POULTRY

INSECT	NATURE OF DAMAGE	CONTROL
Mites (of poultry)	Northern fowl mites; remain on the birds; congregate at vent and neck where they suck blood.	Paint roosts with nicotine sulphate; repeat in two weeks. Treat litter with malathion dust. Dip birds in sulfur 2 ounces, detergent 1 ounce, and warm water 1 gallon.
Fleas (of animals and birds)	May carry disease and tapeworms. Adults small, dark, shiny, jumping insects. Larvae up to ¼ inch long; in bedding.	Thoroughly clean floors, carpets, and especially the sleeping quarters of dogs and cats. Then spray or dust quarters and dust animals with methoxychlor, rotenone, or malathion. Rid dogs and cats of fleas with dusts containing rotenone, methoxychlor, or pyrethrum.

Use livestock insect poisons according to directions on the containers.
Do not use household or oil solutions on livestock.
Carefully observe precautions for humans.

References:

Department of Agriculture, Edmonton

Publication No.: 84—Bang's Disease
136—Blackleg and Allied Diseases
112—Bloat in Cattle and Sheep
14—Diseases of Suckling Pigs
12—Infectious Rhinitis
26—Mastitis—Prevention and Control
89—Rabies
88—Shipping Fever of Cattle
116—Swine Erysipelas
13—Swine Parasites
138—Vibriosis
31—Coccidiosis
29—External Parasites of Poultry
24—Infectious Bronchitis and Newcastle Disease
30—Internal Parasites of Poultry
32—Respiratory Diseases of Poultry
28—Tuberculosis of Poultry

Beekeeping

Beekeeping in Alberta falls into three categories, commercial, sideline and hobby. Commercial beekeepers whose major income is derived from bees operate at least 300 colonies. Sideline beekeepers supplement their regular income with from 40 to 200 colonies, while hobbyists keep from 1 to 25. An average production of 100 to 125 pounds of honey per colony may be expected in most areas with fair management. The price of honey has provided satisfactory investment returns.

Everyone keeping bees is required by law to register the number of his colonies and their legal land location, with the Apiary Branch, Alberta Department of Agriculture, Edmonton. There is no registration fee but annual registration is required.

Before attempting beekeeping, consideration should be given to a few pertinent factors. A person should not be unduly affected by bee stings. Time should be available at the critical periods of management. A study of bee behaviour, management and disease control should be made.

Beginners should start with at least two packages of bees. Any beginner considering beekeeping as a commercial enterprise should spend at least one season with an established beekeeper. Observations can then be made and losses due to dismanagement avoided. Nectar producing plants of the proposed area can be assessed to determine the optimum number of colonies to be operated.

The importance of visiting the Apiary Branch, District Agriculturist, Experimental Farm at Beaverlodge, beekeepers and local beekeeping associations cannot be over-emphasized.

EQUIPMENT

A sanitary, bee and fly proof building should be available for super storage and honey extraction. For every colony a hive cover, bottom board and five supers with 10 frames each are required for satisfactory operation. A bee veil, smoker, hive tool, gloves and coveralls are necessary personal items. The extracting equipment required depends on the number of colonies operated and can be best recommended by a bee supply house, the Apiary Branch, Department of Agriculture at Edmonton, or the Experimental Farm at Beaverlodge, Alberta.

To prevent the spread of bee diseases, specifically American foulbrood, all used bee equipment must be inspected and a permit issued by the Apiary Branch, before such equipment may be bought or sold. In purchasing used bee equipment it is advisable to demand an inspection certificate.

MANAGEMENT

Almost 95 per cent of colonies in Alberta are from package bees imported from California. Although bees can be wintered sucessfully with adequate stores, good laying queens and proper care, the number of colonies wintered is small.

The Italian strain of bees is most popular, although hybrids and Caucasions are preferred by some. Two-pound packages with a queen generally are ordered in February or early March from a reputable supplier like the Alberta Honey Producers' Co-operative at Edmonton, or directly from the package bee shipper. Packages should arrive during the last three weeks of April although in northern areas, early May packages have proved satisfactory. Each brood chamber should have 20 pounds of honey or the equivalent in sugar syrup, and two to three frames of pollen. It is desirable to have a shelter to the north and west of the apiary.

Dandelion and willow provide nectar and pollen for spring build-up. Sweet clover, alsike, red clover, alfalfa, fireweed and rape are the main nectar secreting plants in Alberta. At least one acre of these plants per colony within a 1½ mile radius of the apiary is considered necessary for a satisfactory honey flow.

Colonies should be examined one week after installation for acceptance of queens, and to replace queens not accepted. Bi-weekly examinations until the middle of June will suffice, after which time until mid-July or later, colonies should be examined at least every 10 days for swarm control and provision of supers for the main honey flow. Honey may be exteracted when the combs are two-thirds capped.

Colonies should be killed when the honey flow ceases, usually about the end of August, as unnecessary consumption of stores will reduce the honey surplus. The danger of granulation of honey in the comb, especially near rape fields, is more acute in September than in August.

POLLINATION

The value of bees as pollinators of legume seed crops far exceeds the value of honey produced. One-half to one colony per acre is recommended for clovers. Honeybees do not

significantly increase the seed yields of alfalfa in Alberta although it is visited quite freely by the bees for nectar.

Legume seed growers should make arrangements with commercial beekeepers to provide bees for pollination rather than attempt beekeeping themselves. Operating a large number of colonies conflicts with major farm operations.

DISEASES

Disease control is of utmost importance, and is the responsibility of every beekeeper. American foulbrood is the most serious. It kills the unhatched brood resulting in serious reduction of hive populations and unprofitable colony production. American foulbrood spreads from one colony to another and from one apiary to another if not controlled. European foulbrood is a less serious brood disease, but it too can reduce honey production.

Sac-brood, caused by a filtrable virus, is often prevalent in wintered colonies and less often in package bee colonies. Nosema, an adult bee disease, is mostly present in overwinterized colonies. Any suspicion of disease in an apiary should be reported to the Apiary Branch, or to the nearest District Agriculturist.

MARKETING

The Apiary Branch prepares bulletins on marketing conditions periodically and these are sent out to all registered beekeepers.

Most commercial operators market their honey in bulk. Honey sold directly by producer to consumer does not come under marketing legislation; honey sold through retail outlets must have the name and address of the packer, the grade, and the class of the honey stamped or printed on the main label of the container. Grade is determined mainly by the water content and freedom from foreign material. Class is determined by color. Samples of a small amount of honey (about 1 ounce) may be forwarded to the Apiary Branch for grade and class determination. For complete regulations obtain a copy of the honey grading Regulations from the Alberta Department of Agriculture at Edmonton.

References:

Department of Agriculture, Edmonton
"Beekeeping for Beginners in Alberta"
"Care of Package Bees"
"Package Bees, Their Introduction and Care."
Alberta Honey Producers' Co-operative, Edmonton
"Hive and the Honeybees" Dadant
"ABC and XYZ of Beekeeping" A. I. Root.

Agricultural Engineering

Farm Machinery

Farm machinery should be selected and purchased on the basis of a definite need. Factors such as the potential saving in labour, capacity in terms of the need on the farm, and the availability of service should be considered in relation to price. Over-capitalization in machinery and equipment can be a serious fault in management. Field capacity can be estimated as follows:

$$\frac{\text{Width in inches} \times \text{miles travelled}}{100} = \text{acres covered.}$$

The sizes of the field machines needed on the farm govern the size of the tractor that should be used.

TILLAGE MACHINERY

The primary objectives of tillage for dry land farming are moisture conservation through weed control, and seed bed preparation. Secondary objectives, are erosion control (wind and water), insect and disease control. The secondary objectives can normally be obtained by proper selection of tillage tools for the primary ones. Land shaping, levelling and ditching are important operations in the irrigated areas. The quality of work will depend on soil moisture and the condition and operation of the machine.

Tillage to a depth of 3 to 4 inches is normally recommended. It is rarely of advantage to till deep. Depth is measured by laying a straight edge on the unworked surface and measuring to the bottom of cut. The depth of operation is usually established with the first operation with subsequent operations being the same depth or less.

Plows — The moldboard plow is one of the oldest tillage machines known and is still widely used for breaking hayland and to a lesser extent in stubble plowing. For efficient operation, the plow must be properly hitched and the shares must be sharp. It is important to use a moldboard suitable for the soil and type of plowing. (Further information may be found in the bulletin "Tillage Machinery, Maintenance and Operation.")

Disc Plows — are used in heavy clay soils where the moldboard will not scour properly. The discs are set at an angle to assist penetration. Disc plows leave the soil somewhat rougher than the moldboard plow.

Disc Equipment includes disc harrows, discers and one-way discs. All disc type machines have a tendency to pulverize the soil and should be used with care where soil erosion is a problem. The maximum speed recommended is 4 miles per hour. The proper size machine should be selected to load the tractor at this speed.

The principal difference between the disc implements is in size and spacing of discs. Discs are also available in deep or shallow concavity. Better penetration may be achieved by one or more of the following: adding weight, changing to narrower cut, using deeper concavity blades and sharpening the blades.

Machines with wide disc spacing must be operated deeper to obtain a clean cut. Deeper penetration or narrower cut means greater power requirements, but gives a cleaner cut with any given machine. Proper hitching and adjustments at the wheels are necessary. It may be necessary to add extra weight to obtain the penetration required.

Discs are subject to breakage in stony ground. Breakage may be decreased by one or more of the following methods — decreased speed, wider cut, less weight, removal of stones. (Further information may be found in the bulletin "Tillage Machinery, Maintenance and Operation.")

Cultivators are the most adaptable of all tillage implements to soil conservation and erosion control. Included are duck foot, heavy duty, tool bar, and blade cultivators. Cultivators use shovels or sweeps that cut off weeds below the surface with minimum disturbance to the soil surface trash. Vertical hitch adjustment should be set so that all shovels or sweeps operate at the same depth.

The duck foot cultivator consists of a rigid frame with the shanks usually fixed at a 9 or 10 inch spacing. The shanks may be in two or three rows. The latter gives better trash clearance than the former, but still not as good as heavy duty cultivators. The shanks are rigid with a trip mechanism, which allows them to swing back when striking a solid object. Shovels varying in design and width from 2" to 12" are available. Ten or 12 inch shovels are usually used for weed control.

Heavy duty and tool bar cultivators have heavy rigid frames and the shanks are constructed of heavy spring steel with spring

cushion but no trip mechanism. The shanks are arranged in two, three or four rows and are usually adjustable to give different spacing. A 12" spacing with 14" or 16" sweeps is normal. Chisel points also are available. The heavy duty cultivator has sufficient clearance for most trash conditions.

Blade cultivators consist of one or more wide sweeps on a rugged frame that will clear any trash condition. The blade is wide and steep, depending on a tumbling action to shake roots from the soil. Speeds over 4 miles per hour are recommended. This machine is not satisfactory under wet conditions. See References.

Subsoilers — Working below the 6" depth is not generally recommended. Any advantages that may be gained are outweighed by the increased power cost.

Harrows are available in types including stiff tooth, lever, spring tooth and oscillating. Harrows are used for starting weed growth, killing small weeds and packing after other operations. Care must be exercised where soil erosion is a problem as harrows have a pulverizing action. Oscillating harrows will work in very heavy trash and are effective for spreading dry straw.

Rear Mounted Implements are available with various types of quick hitches and hydraulic control. Depth control is generally satisfactory and these machines are useful when working in small or confined areas. Wide mounted implements are not recommended due to the difficulty in maintaining uniform penetration, particularly on uneven land. Inter-changeability between makes may be a problem. See References.

Row-Crop Cultivators in single or multiple-row units are best used on tractors designed with adequate clearance and wheel-tread adjustment to meet the needs of the crop. The belly-mounted unit, hydraulically controlled, provides better vision and depth control and is more useful for close cultivation than is the rear-mounted tool bar type cultivator. A complete range of cultivator attachments should be available. These are: discs, knives, duckfeet, shields and, in irrigated areas, furrowing shovels. Hillers are available for potatoes. The drilling of straight, evenly-spaced rows and careful, slow-speed operation of the cultivator provide quality tillage without damage to the crop. The width of the drill and the width of the cultivator should be balanced so that the cultivator is not required to span the guess-row.

Row-Crop Thinners are primarily used in Alberta for the mechanical thinnings of sugar beets. Down-the-row thinners are available in either tractor-mounted or trailed types. The former is more easily held on the row. Mechanical thinners, equipped with spring-tyne heads, are useful for pre-thinning, weeding and crust-breaking operations, and when equipped with the proper thinner heads, are used for either partial or complete thinning of the crop. Successful use of the thinner is dependent upon a satisfactory initial stand of beets, the proper selection of thinner heads based on stand counts taken in the field before and after each operation, and careful operation of the machine.

Heavy Duty Disc Machines may be offset, single acting or tandem, equipped with 26" - 30" discs that may be plain or cut-away. These machines are of heavy construction and with added weight may be used for breaking light brush or grassland. Power requirements are high.

SEEDING AND PLANTING EQUIPMENT

The selection of the proper type of seeder is governed by crops to be seeded, soil, climate and the type of farming. In areas where moisture conditions are most favourable to germination, packing after seeding is not essential. The standard high-wheel or low-wheel drill is suited to these conditions. However, the discer or one-way seeder will require the use of a packer to ensure good soil to seed contact. In dry or semi-dry areas, packing is necessary to help provide uniform germination. In these areas, the press-wheel-carriage drill or a packer attachment for the wheel drill, and for the one-way and discer is used.

Disc Furrow-Openers are suited to the seeding of a wide variety of crops, including cereals, oilseed crops, and grasses, where conservation of soil moisture for germination is not a problem. Under very dry seedbed conditions, disc openers cannot place seed into moist soil without excessively deep placement. Disc openers have not provided uniform seed placement when used on fields covered with very heavy trash.

Semi-Deep Furrow Openers (hoe or shovel) mounted on a press-wheel carriage and in a gang arrangement designed to provide good trash clearance, are well suited for use in areas where trash cover farming is practised. The semi-deep furrow seeding principle designed into these drills permits their use on dry or semi-dry seedbed in which moist soil exists at a depth of about 4 inches below the surface. The spacing of the furrow openers varies from 7 to 10 inches in these drills.

Deep-Furrow Drills are used primarily for seeding of fall-sown crops in dry areas. Furrow openers (shovel or large single disc type) spaced 12 or 14 inches apart can be operated at a depth of 4 to 5 inches with a resulting cover of about 2 to 3 inches of soil over the seed,. Deep-furrow and semi-deep furrow drills should not be pulled at a high speed, as this throws an excessive covering of soil over the seed in the furrows.

Combination Grain and Fertilizer Drills are used in areas where the use of commercial fertilizer is an established practice. Fertilizer attachments are available for most styles of seeders. Fertilizer distributing mechanisms, whether on the drill or employed as a separater broadcast spreader, should be carefully cleaned after each use and for storage. Fertilizer absorbs moisture from the air and then corrodes and binds the moving parts of the machine. Fertilizer should not be distributed through the seed cups of the drill because it is abrasive.

One-Way Seeders — The use of the seeder box attachment on the one-way disc and the discer for stubbling-in cereal grain has merit equal to that of other methods of seeding where annuals constitute the major weed problem. On medium to heavy-textured soils, one-way seeders perform equally with other types for seeding summer-fallow. Packing after seeding, careful regulation of depth of seeding, proper seed spout adjustment, and the use of a medium to narrow-width cut are essential to the successful use of the one-way disc seeder. Rubber tires are helpful for maintaining good control of seeding depth.

Broadcast Spreaders designed for the surface application of fertilizer and other materials, should be calibrated to provide accurate application of the material.

Seeders for Grass and Small Seeds — Grass seeder attachments are available for standard drills. These are designed primarily for metering fine seeds such as clover and alfalfa. Slow-speed drive attachments are available for some drills to reduce the speed of the feed-shift. This speed reduction increases the metering accuracy for small seeds such as mustard, rape and clover.

Special seeder boxes mounted on a double-gang packer give good results provided the seedbed has not been firmly packed before seeding. These units pulverize the soil surface, and the threat of wind erosion must be considered.

Row-Crop Planters are designed to handle a wide variety of crops grown in rows. The proper seedplate must be used for each crop. The precision drill for sugar beets, should be pulled at a slow speed (about 2 m.p.h.) and the drill should be kept in good mechanical condition. High speed decreases the rate of seeding and disturbs the accuracy of seed placement. Rows should be as straight as possible to facilitate subsequent cultivation. Fertilizer attachments should be carefully calibrated, and the shoe or runner-type openers should be sharpened to maintain their original shape.

HARVESTING MACHINERY

Swathers should lay a closely knit windrow of grain, which is supported on top of the stubble. For best support the stubble left should be about one-third the height of the original grain but not over ten inches high. The canvas and reel speed should be equal to or slightly greater than the forward speed of the machine.

Power take off swathers are usually inside-end delivery, laying the grain in the windrow at a slight angle to the direction of travel, depending on the design and speed of the machine. The self-propelled swather is a centre-delivery type and lays a criss-cross swath in which all the heads are in the center of the swath.

Combines — Power take off combines require a tractor of ample size to maintain cylinder speed under full load. A live power take off is recommended. An auxiliary engine driven combine of similar size may be operated satisfactorily with a smaller tractor. Self-propelled combines are operated by a single engine but have a variable speed ground drive that is independent of the cylinder drive. Most combines will handle all types of grain crops, grass seed, clover, rape seed, etc., provided the machine is adjusted correctly and the special sieves are used where necessary.

Principal Adjustments:-

1. Cylinder Speed — for a 21" diameter cylinder should be in the range of 900 to 1200 r.p.m. for efficient threshing of most grains.

2. Concaves should be adjusted just close enough to the cylinder to remove practically all grain from the head. Avoid too close threshing as cracking will result and excessive broken straw will carry grain over.

3. The wind blast should be adjusted to hit the front ⅛ to ½ of the shoe and should be of sufficient velocity to lift all chaff clear of the sieve. This allows the grain to fall through the sieve instead of being carried over in the chaff.

4. The top sieve should be maintained well open so unthreshed heads will go through but

still carry off bits of straw. The lower sieve should be set closer to carry off bits of unthreshed heads but still allow the clean grain to fall freely through. The sieves must not be closed so tightly as to restrict air flow. See manufacturers' recommendations for further information and adjustments for special crops. See References.

Combine Attachments — The pick-up reel is made up of rows of rake-like fingers instead of bats and is very useful in badly lodged crops. The speed of the reel must be correctly adjusted.

Grain saving guards or pick-up fingers are useful for saving tangled and lodged grain but will not work effectively if the crop is weedy. Pick-up reels and pick-up fingers should not be used together.

Wind reels may be used to reduce shelling losses.

Recleaners are useful for removing weed seeds and cracked grain.

Straw cutters are available for most combines and will shred and spread the straw. Three to eight horsepower is required to operate these attachments.

Straw bunchers are available commercially, or may be readily made by the farmer and provide an easy method of collecting combine straw for feed or bedding. (See "Methods of Collecting and Handling Combine Straw").

Straw binding equipment that ties loose rectangular bales is abailable, and this equipment mounts on the rear of the combine.

A device that measures the grain by volume as it is threshed, is available.

Sugar Beet Harvesters — Several types of machines are available. Single-row units, tractor mounted and employing self-unloading trailercarts, have a capacity of 3 to 5 acres per day. Daily capacity is strongly influenced by efficient use of hauling facilities and by harvesting conditions. Single-row machines have adequate capacity for 40 to 60 acres per season under most conditions. Growers producing less than 20 acres of beets per year should consider either joint ownership or custom operation to justify the expense.

Multi-row harvesters generally require two operations to top and lift beets. Economical ownership requires seasonal use on 60 acres or more.

Ground toppers and within-machine toppers should be operated at moderate speed of 3 to 4 miles per hour. High-speed operation can result in inefficient topping, poor root recovery, and excessive breakage of tap roots as a result of failure to drive on the row. High quality work requires careful adjustment of the machine.

Top-saving devices are available on most machines and, where tops can be utilized for feed, care should be taken to preserve the quality of the feed. A side-delivery rake can be used to shift the windrows of tops to avoid trampling by trucks and the harvester.

Trailer-carts equipped with a sorting table or a sorting belt are useful for the manual removal of clods, although extra labour is required. The use of the cart facilitates the integration of the harvesting and hauling of beets. Under muddy conditions the truck can be left on a firm headland and the beets taken in the cart to the truck. Under severe conditions a second tractor has been used to help move the harvester in the field.

HAY AND SILAGE MACHINERY

Forage crops may be harvested as dry hay or silage. Green oats or barley are frequently harvested as silage. The equipment and system used will depend on the size of operation, method of storage, climatic conditions and labour requirements.

Mowers — Power take off mowers are available in side counted, drawbar mounted and trailing models with hydraulic or mechanical lift. Some models are available with "pitmanless" knives which are vibrationless. The development of the serrated knife has reduced the problem of knife maintenance.

The important adjustment are pitman and cutter bar alignment and knife registration. The knife bar end of the pitman should have a lead of ⅛" to ¼". The outer end of the cutter bar should lead the inner end 1/8" for each one foot of cut. The knife sections should centre on (register) a guard at each end of the stroke. See Reference.

Swathers may be used for cutting and windrowing some hay crops.

Rakes — Dump rakes are for use where hay is to be handled by sweep or hand. Where balers and forage harvesters are used, it is necessary to use a slide delivery rake to form an even continuous windrow. Several types of rakes are available in power take off or ground drive. Power take off drive limits the selection of tractor gears, while ground drive may be operated in any gear and at a speed suitable to the conditions. The large wheel rakes and newer side rakes (variously called oval action or parallel bar) window with less movement of the hay than the older reel type of rake.

Sweep Rakes and Stackers — A sweep rake mounted on the front of a tractor may be used

to collect hay and bring it to various types of stackers. The hydraulically operated sweep stacker has largely replaced the separate sweeps and stacker.

Stack Movers are available that will handle stacks up to 16 feet wide and 30 feet long, and up to 7 tons in weight. Stacks may be conveniently and economically moved over a considerable distance. It is suggested that two or more farmers share the cost.

Balers provide an economical method of processing hay for shipment or long hauls but do not reduce the man hours of labour per ton. Balers are available to make round or rectangular bales. The bale weight varies from 30 to 100 pounds, depending on the material, size of bale and the tension of the bale chamber. Wire or twine tie models are available. Twine is cheaper and most commonly used, but wire is preferred for commercial handling. Balers may be engine or power take off driven, and a live p.t.o. is desirable but not essential. For power requirements see section on farm power.

A uniform windrow is essential for efficient and trouble-free baler operation. Moisture content should not exceed 20%.

Knotters are the most common source of trouble but will give satisfactory service if manufacturers adjusting and operating instructions are followed.

Bale Loaders and Elevators are necessary to save time and manual labour. In stacking, a loose layer of straw or hay should be placed on the ground to prevent rotting of the bottom layer. The stacks should be kept narrow and well topped.

Forage Harvesters are available in three main types — reel type cutter, flywheel cutter and flail type. The flail type is a recent development and consists basically of a shaft rotating against the direction of travel on which is suspended free swinging knives or chains. The flail, as well as cutting standing crop or lifting swathed material by suction, also acts as the blower in most models while some use an auxiliary blower. These machines are relatively simple and less expensive. The first two have a cutting or chopping action which usually is adjustable from a theoretical cut of 1/2" to 4". The flail type has more of a shredding action which does not cut the material as uniformly.

Forage harvesters are used for putting up chopped hay or silage. Chopped hay and silage should be stored in or near the feed area as it is not easily moved. Self feeding should be considered. Forage wagons and blowers plus necessary tractor power are required to haul and store the material as it is chopped.

Dry hay may be picked up from the windrow with a pick up attachment on conventional harvesters and without attachment by most flail machines. Chopped hay may be stored in outside bins made of snow fence or similar material or may be blown into lofts or inside bins. Outside stacks should be topped (with long hay) to shed water. Dry hay should not be cut into less than 4 inch lengths and should contain not more than 20% moisture.

Green hay cut for silage should have a moisture content of 65% to 75%. Good silage may be made from forage cut to any length, but coarse material requires more packing. Conventional harvesters may use the pick-up, as for dry hay, or can be used for direct cutting by means of a sickle bar and reel attachment. Most flail machines will pick up a windrow or direct cut without attachments. The choice of methods will depend on the moisture content of the standing forage and climatic conditions. (For further information see the bulletins, "Harvesting Machinery for Hay and Silage" and "Grass Silage for Alberta.")

SPRAYING AND DUSTING EQUIPMENT

Low-pressure, low-volume, boom-type sprayers are commonly used for the application of herbicides at solution volumes as low as 4 gallons per acre at about 4 miles per hour. Field sprayers have been successfully mounted on trucks, tractors, trailers and self-propelled swathers. Careful maintenance and calibration of the nozzles is required for good results, especially when low volumes are used. Auxiliary hand guns are useful for spraying isolated weed patches in the field and around the yard. Field sprayers can be adapted for use with some other materials. The bronze gear pump is not as suitable for the application of wettable powders as are the roller-type and the positive displacement piston-type pumps.

Boomless sprayers are well adapted for spraying roadsides and ditch banks. Good results can be obtained in the field, provided wind effect on the spray pattern is taken into consideration.

General purpose sprayers can apply chemicals at low volume and low pressure. However, they should be capable of operating at pressures up to 500 pounds for spraying live stock, buildings and trees, and for other applications requiring the use of high pressure. The pump must be capable of handling wet

table powders. The tank should be equipped with a mechanical agitator and should be readily accessible for cleaning.

Herbicide sprayers must be thoroughly cleaned with warm, soapy water followed by thorough rinsing before they are used for the application of insecticides. Herbicide sprayers should not be used to apply insecticides to crops highly susceptible to the herbicide.

Aircraft spraying is especially suited to the application of insecticides and herbicides to large areas or to areas inaccessible from the ground. Since carrier volumes as low as 2 quarts per acre of diesel fuel are used, the equipment must be carefully calibrated to provide uniform coverage.

Dusters may be used to apply herbicides or insecticides in the dust form. They may be operated at somewhat higher field speeds than are used for sprayers.

Row-crop sprayers for the application of insecticide should provide for nozzle placement over the row and for down pipes between the rows. The down pipes and overhead nozzles should be adjustable for height and for direction of spraying to give complete coverage of the upper and underneath surfaces of the plant. The pump should be capable of delivering 20 to 40 gallons per acre at pressures of about 100 pounds over a 4 or 6-row boom. Low-pressure, low-volume field sprayers frequently do not provide sufficient coverage for the successful application of insecticides.

(Further information on spraying and dusting equipment can be found in "Weed Control With Chemicals," Bulletin No. 83, Alberta Department of Agriculture.)

OTHER FIELD MACHINES

Rotary Mowers are power take off operated and may be used to cut and shred weeds, brush and tree growth up to about 1½" diameter. Power requirements are not excessive. Protective shields must be used to prevent injury and damage from the rotating blade and flying pieces of wood.

Stone Pickers operate satisfactorily on stones under 10" diameter if they are on the surface and the soil is dry, firm and devoid of trash.

Land Clearing—Crawler tractors with mounted brush cutters and pilers are most satisfactory. A crawler tractor and bulldozer will cut and pile in one operation when the ground is frozen. (See references.)

Farm wagons, Trailers and Racks are used for transporting hay, grain, bales, silage, etc. and are available commercially or may be built by the farmer. (See bulletin, "Farm Trailers, Wagons and Racks.")

MACHINERY FOR IRRIGATION

Ditchers — Three types of ditchers are: the fixed-double-wing, the adjustable-double-wing, and the adjustable-single-wing. Double-wing units form field ditches without the preliminary use of a plough. A plough furrow is necessary with the single-wing unit. Two or three trips are required to form a properly shaped ditch with firm, high banks.

Float Levellers are used to smooth small surface irregularities on a field that is to be irrigated by gravity methods. They are equipped with either an automatic hydraulic control for the scraper blade or a mechanical linkage between the blade and gauge wheels or a gauge plate. It is frequently desirable to pull harrows behind the leveller to roughen the field slightly to help prevent soil drifting. Homemade levellers should be at least 20 feet long and not over 8 feet wide for good floating action. An 8-foot blade on a commercial unit requires at least a 4-plough tractor, while a 10-foot blade should be pulled by a 5-plough tractor.

Ditch Fillers — Tractor-mounted ploughs, mounted in-throw disks, and mounted grader blades can be used for filling field ditches before the crop is harvested. Mounted disk-type bedders have given good service for this purpose.

Scrapers — Small carry-all or bucket type scrapers, varying in capacity from one cubic yard and upwards, are useful for small earth-moving jobs on the farm. Major land-shaping and earth-moving projects usually justify the use of industrial equipment.

References:

Dept. of Agriculture, Edmonton
Tillage Machinery, Maintenance and Operation
Grass Silage for Alberta
Pub. 83—Weed Control with Chemicals

Dept. of Agriculture, Ottawa
Pub. 879—Blade Cultivator Operation and Maintenance
Pub. 999—Traction Problems with Mounted Tillage Implements
Pub. 746—Mower Repairs and Adjustments
Pub. 885—Harvesting Machinery for Hay and Silage Harvesting Malting Barley
Pub. 814—Power Machinery in Bush Land Improvement

POWER MACHINERY

Plow Capacity of Farm Tractors

Relation of approximate plow capacity in terms of 14 inch bottoms and rated drawbar horsepower (taken from Nebraska Tests) and also practical field horsepower rating:

Approx. Plow Capacity in terms of 14" bottoms	Available H.P.*	Rated Drawbar H.P. (Neb. tests)
	7	8
1		
	11	14
2		
	18	23
3		
	26	32
4		
	33	41
5		
	40	50
6		
	47	59

½ Under practical field conditions, the Nebraska ratings cannot generally be achieved because of the following reasons:

—Altitude effect: Alberta is from 2,000 to 4,000 feet above sea level. This results in reduced power output.

—Temperature effect: Nebraska ratings based on 60° F. Higher temperatures reduce power output.

—Engine condition: Nebraska test engines are tuned up to peak performance. Average tractor in the field is 10-15% below this peak.

—Field and traction condition: Nebraska tests conducted on level track with good traction. Tractors have up to 5,000 lbs. added weight for traction. Average tractor does not have ideal operating conditions.

Note: Available Horsepower to be used in matching tractor to equipment.

Table of Horsepower Requirements of Tillage Implements

Implement	Depth	Speed M.P.H.	HP/ft. of width
Plow — slow speed	4-5"	3½	3 -4½
Plow — high speed	4-5"	4½	4 -5¼
Disc Plow	4-5"	4	5½-6½
One-Way Disc	3-4"	4	2 -2¾
Discer	3	4	1¼-2
Blade Cultivator	3-4"	4½	1½-3½
Cultivator	3-4"	4½	1½-2½
Rod Weeder	3	4	¾-1¼
Drag Harrow	—	4	⅜- ½
Oscillating Harrow	—	4	⅜- ½
Seed Drills	—	4½	¾-1¼

Table of Horsepower Requirements of Haying and Harvesting Machines

Balers, pick up engine mounted	1 to 2½ HP/ton/hr.
Forage Harvester ½ inch cut	1 to 3 (PTO) HP/ton/hr.
Combine — PTO	2 to4½ (PTO) HP/ft. of cutter bar
Combine — engine mounted	2 to 3 HP/ft. of cutter bar
Threshing Machine — 22 inch cylinder	20 belt HP
Threshing Machine — 28 inch cylinder	35 belt HP
Hammer Mill	¼ to¾ HP/bushel/hr.
Plate Grinder	⅛ to½ HP/bushel/hr.

Characteristics of Different Power Sources at Various Loads

Increase in fuel consumption per HP at part loads expressed as percent increase over rated load.

	Rated	¾ load	½ load	¼ load
Gasoline and Propane	0	10	33	100
Diesel	0	5	20	80

This table illustrates that the diesel is more efficient than the gas or propane engine at part loads.

Selection of Stationary Power Unit

Power plants should deliver sufficient power at the specified speed with maximum operating efficiency. Internal combustion engines and electric motors are by far the most common types of power units.

The selection of type depends on:

(1) The amount of power required
(2) The initial cost
(3) Availability and cost of fuel or electricity
(4) Annual use
(5) Duration and frequency of operation

Electric motors have many advantages over internal combustion engines, such as ease of starting, low initial cost, low upkeep, wide range of operating temperature tolerance, long life and suitability for mounting on horizontal or vertical shafts. Direct drives are possible, eliminating gears and belts. Water tight vertical motors are available for deep well operation. On most farms, a limitation is placed upon the size of electric motor by the power company. The maximum size may be 5 or, in some cases 7½ H.P. For larger

power requirements, internal combustion engines are required.

Diesel engines are justified when the annual hours of use are high because of the fuel savings. A propane engine will run longer between overhauls as a result of the cleaner engine operation.

A comparison of the fuel costs for tractors burning different fuels is shown in the following table:

Average Fuel Consumption and Cost of Fuel per Hour

Belt	Fuel Consumption—gal/hr			Fuel Cost—cents/hr at indicated prices		
HP	Gas.	Diesel	Propane	Gas. 20c/gal	Diesel 17c/gal	Propane 16c/gal
10	0.72	0.55	0.97	14.4	9.4	15.6
20	1.44	1.11	1.95	28.8	18.8	31.2
30	2.16	1.66	2.92	43.2	28.2	46.8
40	2.88	2.22	3.89	57.6	37.6	62.4
50	3.60	2.77	4.87	72.0	47.0	78.0

Example:

For a 50 HP tractor:
diesel save (72-47)=25c/hr over gasoline
propane costs (78-72)=6c/hr more than gasoline.

These figures are valid only for the fuel prices indicated. Different fuel prices will yield different hourly costs.

Other factors to be taken into consideration in calculating total operating costs are:

(1) Hours of annual operation.
(2) Original tractor cost — a higher priced tractor has higher interest and depreciation costs.
(3) Difference in repair or maintenance costs —propane engines will generally have lower repair costs.
(4) Fuel storage equipment — propane fuel storage tanks and equipment are expensive.

(Reference—Cost of Operating Tractors — Thompson, Bigsby, Kemp)

For continuous operation, best results are obtained with the following loadings:

Electric motors	full rated capacity
Diesel engine	80% rated capacity
Gas or Propane water cooled	70% rated capacity
Gas or Propane air cooled	60 %rated capacity

When an engine is operating unattended, protection devices are recommended. These devices will stop the engine if it overheats, or if the oil pressure is low.

Traction

There are several ways of converting tractor energy into useful work. The drawbar is the most used and least efficient.

The traction capacity of a rubber tired tractor is approximately proportional to the total weight on the tires. The maximum drawbar pull is approximately one-half the weight on the driving wheels. If the tractor provides insufficient weight, liquid can be added to the rear tires or concrete or cast iron weights can be fastened to the rims.

Tires should not be loaded beyond the manufacturer's recommendations. The liquid should be a calcium solution for frost protection. There is no significant difference in traction performance between the use of liquid or cast iron ballast. Also, there is little difference in performance between different tread designs. Tire inflation pressures should always be sufficient to prevent side wall flexing.

The rubber tire has generally been replaced by the track in the larger size tractors. Tracks reduce ground pressure and rolling resistance in loose, soft soil surfaces. The track type tractor can exert a higher drawbar pull than the rubber tired tractor with the same total weight. Land clearing operations are best carried out with tracks or steel wheels. Crawler tractors are not widely used on sandy soils because of high track maintenance.

Remote Power Application

In addition to power being delivered and used at the drawbar, it can be transmitted to the implement by other methods. These are:

(1) Belt
(2) Power Take-Off
(3) Hydraulic Control Systems
(4) Electric Generator and Motor Combination

Belt

The belt was the first method developed, but is now being replaced by the other methods.

The standard belt speed is 3,100 ft. per minute, plus or minus 100 ft. per minute. The belt pulley should be wide enough to accommodate a 6 inch belt. Belts should never be put on or pulled off while there is power in the driving pulley.

Power Take-Off

The A.S.A.E.-S.A.E. PTO standard adopted in 1923 provided for a speed of 536 plus or minus 10 rpm. Since then, there have been increased power demands upon PTO drives and more capacity is required. This is being accomplished by increasing the standard speed to 1,000 plus or minus 25 rpm.

Until such time as all tractor PTO and implement shaft speeds are the standard 1,000 rpm, conversion kits will be required. These may be obtained where the tractor PTO is 1,000 rpm and the implement shaft 536, or when the PTO is 536 and the implement is 1,000. The manufacturer's instructions should always be followed in adjusting and operating PTO shafts.

Safety shields must always be kept in place. The new tubular shields are non-removable.

Hydraulic Control Systems

Hydraulic controls for farm equipment are very flexible and have a wide range of application. There are two general types of control systems:

—Limit Control

—Proportioning Control

In limit control, the implement is raised or lowered by moving the control lever to either side of its neutral position. The piston in the power cylinder continues to move until the lever is returned to neutral or until the travel is limited by a stop. The position of the implement is adjusted by visual observation.

In proportioning control systems, the position of the lever indicates a definite depth or draft of the implement. There are two types of proportioning control systems:

In automatic position, the hand control lever indicates a definite depth of implement. In automatic draft, the hand control lever indicates a definite draft of the implement.

The oil used in an hydraulic system is very important. The manufacturer's recommendations should always be followed. Dirt is the greatest enemy of an hydraulic system. The oil should always be kept clean and the quantity maintained at the proper level.

Electric Generator and Motor Systems.

An electric generator can be driven from the engine of a tractor and the power used to operate an electric motor or motors, either stationary or on a moving implement. This system provides a maximum flexibility because the electrical wires can be taken easily to any location.

A standard A.C. generator supplying 110-220 three phase power is available and this can also be used as a stand-by unit in case of regular power line failure.

Farm Buildings

The open plan, low, single storey farm building is being used in increasing numbers. The post or partition-free interior provides a utility type structure that can be used for any one of several purposes. This shape of building, together with on-ground storage of feed and bedding, facilitates mechanical handling of these materials, and at the same time eliminates expensive loft storage. It also enables self feeding of forage material.

Foundations

Concrete is the conventional foundation material for farm buildings but it is being replaced to some extent by pole construction and post-pier foundations. This change has been made possible by pressure treated poles, posts and sheathing. In all cases it is important that sufficient footing be used for the soil and structure concerned. For a concrete foundation, a footing at least 16" wide should be used, and as a general rule the wall will be 8" thick. For a rigid frame or round roofed building the foundation wall should be of the buttress type to prevent the lateral thrust from tipping it over. Where a pole frame structure is constructed on clay soil and the poles are spaced 12' apart around the building, a concrete or crushed rock pad approximately 21" in diameter should be installed under each pole. For a post-pier foundation where the posts are 4' apart, the pads should be approximately 12" in diameter.

Where concrete is used for the foundation or the pads, it should provide maximum strength which means the use of clean, well graded gravel and sharp, clean sand in the correct proportions and mixed with as little water as will give a workable batch. Field stones are not recommended for inclusion in concrete. (See references.)

Table of Concrete Mixes

Type	Uses	Proportions				Max. Stone Size
		Cement	Sand	Gravel	Water	
Waterproof	Basement walls, Floors, Steps, Sidewalks, Septic Tanks, Cisterns	1 sack (equals 1 cu. ft.)	2 cu. ft.	3 cu. ft.	4 gal.	1" diam.
Permeable	Thick Footings, Heavy Foundations Walls (not waterproof) Engine bases	1 sack	2½ cu. ft.	4 cu. ft.	4½ gal.	1½" diam.
Thin Sections	Fence Posts, Garden Furniture, Concrete about 2" thick.	1 sack	2 cu. ft.	2 cu. ft.	3¾ gal.	¾" diam.

Note: 1. A mix of 1 : 2 : 3 is **not** the same as a 1 : 5 mix of combined sand-gravel, but will be close to a 1 : 3½ mix.

2. Water suggested is for **moist** sand. For wet sand the water should be decreased 1 gal. per sack. The resultant concrete should be rather sticky, and about the consistency of stiff porridge.

3. If concrete sticks to barrel of mechanical mixer, slow the machine down appreciably.

(Adaptation from Canada Cement Co. publication, "Concrete on the Farm".)

The post-pier foundation offers an insulated foundation wall, which is a worthwhile feature in a heated animal building. For a storage building the post-pier foundation would be constructed with a single layer of sheathing, and in either case this type of foundation is somewhat more economical than the concrete unit that it replaces.

Post Pier Foundation

The pole frame building provides a continuous wall from below grade level to the top of the wall. This is desirable when the loading in the building results in an outward thrust near the floor, such as occurs with a manure pack. For utility buildings it is suggested that the poles be set 12' apart around the outside of the building and that roof trusses be used to give the clear span or utility type structure. See References.

Wall construction for service buildings has been mainly frame with 2 x 4 or 2 x 6 studding at either 16" or 24" spacing. This type of construction is being replaced to some extent by round roof arches or rigid frames that provide both wall and roof framework as a continuous member. These are generally set on 24" spacing for most economical construction.

Laminated rafters or trusses may be used for the framework of a clear span arch building or for the round or gothic roof on a conventional barn. Bent-to-round lamination is much more economical than sawn-to-round lamination.

Bent-to-Round Arches

The best quality lumber is used for the outside and inside laminations, with quality being less important as the center lamination is approached. Glue must be used on the material, which is usually 1 x 3, to weld the truss into a solid unit. Casein glue is satisfactory except where severe wetting of the truss is likely. The trusses or rafters are built up in a jig on either the floor or ground. In assembling, it is important to stagger the butt joints so that joints in adjacent plys are about 6' apart, and anywhere throughout the rafter or truss the joints are about 2' or more apart. See References.

Rigid Frames

Use dimension material and plywood at the haunch joints. They are simple to make but the plans must be followed exactly, especially for the lower wall as it is the slope of this portion that permits relatively light framing material to be used. See References.

Sheathing and Bracing

For wall and roof construction, horizontal 1" sheathing or siding must be strengthened by bracing. Two by four cut-in bracing has been used to a great extent, but it is definitely inferior to 1 x 4 let-in bracing. Here a continuous length of 1 x 4 is fitted into diagonal

notches on the outside of the studs or truss material. Diagonal sheathing eliminates the necessity for such bracing, but almost always requires covering for appearance. Sheathing grade plywood, either 5/16" or ⅜", offers more strength against racking than any type of bracing, and at the same time it may be used to provide the finish surface. Plywood should be applied with the face grain running perpendicular to the framework. This means that on stud walls the sheets run horizontally, and on pole frame construction they will run up and down. The horizontal joints may be of either the lap or the butt type, with the former giving the simplest construction. For waterproof butt joints on the walls, calking compound and nailing strips must be used on the horizontal joints, but this is not necessary on the vertical joints.

Roofing

For the cheapest initial roof cost, plywood may be considered, either 5/16" or ⅜" thickness being satisfactory, with the latter recommended. This will provide sheathing, weatherproofing and bracing when applied shingle fashion to rafters or trusses 24" or 16" on center. Calking compound and nailing strips are necessary to provide a waterproof roof. Surface protection in the form of creosote or penta stain should be provided as soon as possible after the building is completed. (See "Dairy Barns for Alberta" for application of plywood.)

Asphalt shingles, rolled roofing, metal (either aluminum or galvanized iron), or cedar shingles may also be considered for the roof. Shingles or rolled roofing must be applied over solid decking, and bracing is advisable unless the decking is put on diagonally or plywood is used. Metal may be put on to nailing strips rather than solid decking but bracing is necessary. If hail is experienced even occasionally, the use of aluminum should be questioned, and if used, should be over solid decking. Metal used on a curved building should be pre-formed to fit the curve. This will reduce the amount of nail pulling, an objectionable feature with all metal sheathing.

Floors

The floor requirements in farm service buildings vary considerably. In grain storage buildings the floor must include a moisture barrier so that soil moisture cannot move up through the flooring material. Wood floors on top of relatively heavy wooden joists have long been used for this purpose but in new construction, concrete with a polyethylene moisture barrier will be more economical and just as satisfactory. In animal housing buildings, such as beef sheds, loose housing dairy barns and poultry houses using deep litter, gravel floors appear to be satisfactory. However, where the building must be cleaned regularly, such as hog barns and stanchion dairy barns, a concrete floor is recommended.

An insulative surfacing material made up of equal volumes of cement and vermiculite, mixed to a stiff consistency and applied 2" thick over standard concrete, appears to improve the comfort conditions of a concrete floor. This material is strong enough to stand up under the hoofs of swine but has not been tested under cattle.

Heating and Ventilation

Animal buildings, where controlled conditions are required, present additional problems and the most critical of these is moisture removal. This is the main function of the ventilating system. This in turn depends on the heat supply, which is related to the number of animals in the building, the insulation, the inside temperature required and whether or not supplemental heat is available. Insulation equivalent to 2" of mineral batt type materials or 4" of shavings or straw, is considered to be the minimum requirement for wall insulation in this climate. Ceiling insulation should be 1½ times that of the wall.

Because moisture problems are severe in all except loose housing type animal buildings, both the insulation and framing material should be protected by a vapor barrier. It is suggested that polyethylene be used for this purpose and should be provided in addition to the vapor barrier that is already on the batt material if such is being used. The vapor barrier is placed as close as possible to the warm surface, which means in most construction directly under the inside sheathing. It is just as important on the ceiling as on the walls. A vapor barrier is never used on the cold side of the wall.

After precautions have been taken to save as much heat as possible and to control the moisture so that it cannot destroy the building materials, it is possible to proceed with ventilation. In any system of ventilation, warm, moist air is exhausted from the building and replaced by cold, relatively dry air from outside. In the simpler types, the warm, moist air is collected by a flue or fan and discharged directly from the building, while an attempt is made to introduce the cold air in a thin ribbon around the upper perimeter of the

building. This is done in order to prevent cold drafts. A flue system will tend to over-ventilate during extremely cold weather and under-ventilate during moderately warm weather, and automatic control is relatively difficult to obtain. A simple fan system, providing the fan is left running continuously during the ventilation season, will ventilate at a steady rate, which is superior to the performance of the natural draft system. Even this can be improved by regulating the amount of air that the fan picks up, either by the use of a two-speed fan or by the use of a motorized damper and thermostat. These controls should reduce the warm air output to about one-half during cold weather. See References.

In most hog and poultry buildings, supplemental heat will be required during extremely cold weather. This can be most economically provided by a heater which only warms and circulates the air in the building. A ventilation system will introduce and expel the necessary amount of air either for humidity or temperature control. Usually no attempt should be made to combine the separate functions of heating and ventilating into one unit.

Building Maintenance

Frame constructed farm service buildings represent an appreciable investment and their life can be extended appreciably by the periodic use of paint or other protective coatings, and this should be considered as essential a part of the construction as good foundations or weatherproof design.

REFERENCES:

Department of Agriculture, Edmonton
Concrete on the Farm
Pub. 7 — Dairy Barns for Alberta
Plan 547 — Barn Ventilation
Plan 550 — Trussed Rafter
Rigid Frames and Glulam Arches

Electrical Power

Electric power on the farm is expanding rapidly and is generally available on the farm as 115/230 volt single phase A.C. It is an economical and flexible source of power that can be utilized for lighting, motive power, and heating. Electric power is very adaptable to automatic and semi-automatic installations that will reduce labor requirements on the farm.

A permit, obtainable from Electrical Inspection Branch, Department of Industries and Labour, is required for a new installation or additions to existing wiring. Where an electrician is employed he will obtain the permit, while if he is doing the work himself the farmer must obtain the permit. In the case of a new service connection, the permit is the authority for the power company to supply the installation.

Planning the System

Before a building is wired it is desirable to plan the wiring carefully in order that the service entrance and wiring are adequate to handle future requirements. This planning will eliminate costly re-wiring of a building at a future date.

The farmstead may be wired with the conventional overhead system. However, underground wiring presents advantages and the installation costs are approximately the same. In planning the wiring system, consideration should be given to connecting the water pump so that it will be operative for fire fighting, even after power has been cut off at the buildings.

Protective Equipment

The circuit breakers in the service entrance panel will provide overcurrent protection. However, an electric motor requires overload protection. Without the overload protective unit it is possible to burn out the motor even though there is not sufficient current to trip the circuit breakers. Some electric motors are equipped with an overload protection unit built into the frame of the motor, whereas others require the overload protection unit to be wired into the supply line circuit.

Grounded NEMA outlets provide protection against electrical shock from faulty electrical equipment. NEMA grounded outlets are required in all farm installations. All electrical equipment that does not plug into an outlet, but is wired permanently, must also be grounded. Grounding of electrical equipment, such as electrical watering bowls, is particularly important to protect livestock.

When purchasing any electrical equipment for the home or farm, make certain that it has the C.S.A. (Canadian Standards Association) approval on it.

Heat Lamps

The proper installation of heat lamps will eliminate a fire hazard and breakages that so often accompany a haphazard installation. The correct lamp receptacle should be used and the unit must be suspended by a chain and not by the cord. Farm Wiring Regulations outline additional requirements for a heat lamp installation.

When selecting an electric motor, the speed of the driven machine should be considered as electric motors are generally available in speeds of 1140, 1725 and 3450 r.p.m. The electric motor has a number of advantages over the gasoline engine (see section on "Farm Power"). the electric motor will operate con-

tinuously under full rated load, while the required can be 1/2 to 2/3 that of the gasoline internal combustion engine can only operate engine it replaces. Electric-motor driven at 60% to 80% of the rated capacity. For machines that are difficult to start will require this reason, the size of an electric motor a capacitor or a repulsion-indication motor.

Starting Characteristics of Single Phase Electric Motors

Type of Motor	Starting Torque	Maximum Starting Current
Split Phase	Low, 1-2 times running torque	High, 5-7 times running current
Capacitor	Medium, 2-4 times running torque	Medium, 3-4 times running current
Repulsion Induction	High 3-5 times running torque	Low, less than 3 times running current

See References.

Farm Utilities

Water Supply

The well is the most common source of a farm water supply and generally is free of disease producing bacteria. In some cases well water may contain salts that impair the quality; however, in most cases they can be removed. If a well is contaminated it is generally by surface water entering the well, and this can be prevented by sealing off the top against infiltration. Surface drainage should be provided away from the well. Springs are a form of well and generally provide a good source of water.

Dugouts, streams, lakes and ponds will generally provide an adequate supply of water. However, if used for domestic purposes they must be filtered and treated.

Water Systems

The type and size of the pumping unit will depend on the capacity of the well, volume of water to be used and the depth of well. A jet pump has the advantage that it need not be located directly over the well. However, it is not desirable for use on a low capacity well or a well where the lift exceeds 100'. The reciprocating pump, and particularly the balanced beam type of pump, is recommended for low capacity wells and can be used for any depth required. The submersible pump is generally used as a deep well, high capacity pump.

Piping

Any yard piping should be placed at a minimum depth of 8' underground to prevent freezing. Three-quarter inch pipe should be the minimum size for yard piping, and in many cases a larger size may be necessary to ensure an adequate flow of water, particularly where water is moved long distances. Polyethylene pipe is easy to install and low in cost. Galvanized pipe and copper pipe are more difficult to install in trenches and the cost is higher. Ice in metal pipe may be thawed by an electric welder. Copper or galvanized pipe should be used for inside plumbing and plastic must not be used for this purpose, according to present regulations.

Sewage Disposal

Safe sewage disposal on the farm is an important health consideration. The septic tank system has been proved the most satisfactory. The septic tank should be a two-compartment type with a syphon or pump chamber to prevent freezing of the sewer line and field. The life of a steel tank is generally 7 to 10 years, therefore it is desirable to use a concrete tank. A field is the most satisfactory method of disposing of the effluent from the septic tank. In some cases a cesspool or sand filter may be preferable.

Heating

Alberta farmers have a choice of fuel. Natural gas is the cheapest, and, where available, will normally be used. Where natural gas is not available there is a choice of coal, oil, propane and electricity. The cost of electricity makes it prohibitive for heating the home or farm buildings. However, there are applications, such as heat lamps, radiant heaters and water heating, where it may be used to advantage. Coal, oil or propane may be used for heating the home or other buildings. An automatic coal stoker furnace will normally cost more to install than oil or propane, the fuel costs will be low, but the fuel is not as clean to use as oil or propane.

The following table will give the comparative costs of each fuel at various prices:

Fuel	Price		Useful Heat for each cent
	331/3c/M cu. ft.		21,500 B.T.U.
Natural Gas	50s/M cu. ft.		14,300 B.T.U.
	80c/M cu. ft.		8,960 B.T.U.
Coal—Stoker	$ 4.00/ton		20,000 B.T.U.
Strip	7.00/ton		11,400 B.T.U.
Drumheller	16.00/ton		6,250 B.T.U.
	15c/gal.	gun	8,440 B.T.U.
Oil	20c/gal.	gravity (pot type(	7,380 B.T.U.
		gun	6,300 B.T.U.
		gravity (pot type)	5,460 B.T.U.
Propane	15c/gal.		5,450 B.T.U.
	20c/gal.		4,080 B.T.U.
Electricity	2c/Kwh.		1706 B.T.U.

The efficiency of the heating unit has been considered for each fuel so these costs are comparative.

e.g. Compare coal at $4.00/ton — stoker furnace with oil at 20c/gal. — gravity burner) and Propane at 20c/gal.

From table:

Coal at $4.00 ....20,000 B.T.U./c .... Cost 1.0
Oil at 20c (grav. bur.) .... 5,460 B.T.U./c 3.7
Propane at 20c ..... 4,080 B.T.U./c 4.9

i.e. in this example, oil costs 3.7 times, and propane 4.9 times, as much as coal.

Electricity

Rural electrification is one utility that has eased the chores on the farm considerably, and since this subject has been dealt with nothing further will be considered.

REFERENCES:

Dept. of Agriculture, Edmonton
Farm Water Systems and Sewerage
Treatment of Farm Water Supplies
Pub. 36 — Cost Comparison for Water Heaters
Pub. 110 — Rural Electrification
Depart. of Health, Edmonton
Private Sewage Disposal
Depart. of Industries and Development, Edmonton
Regulations Governing Interior and Farm Wiring

Materials Handling

Materials handling is any operation which changes the location of a material, the moving of things from one place to another.

Development is directed towards eliminating those restrictions on the size of a farm enterprise, which are determined by how much the farmer can move, carry or distribute in his working hours. Every phase should be regarded as a link in a sequence of operations including transportation and storage, with clear recognition that any step can slow the whole operation.

Materials handling is often inefficient, because of outmoded methods such as fork and shovel operations. As an example of the discrepancy between field and farmstead mechanization, silage handling in the field is done by forage harvesters while only 4% of the silage is removed mechanically from the silos. This example points to the need for considering the overall process, rather than single operations.

HANDLING GRANULAR MATERIALS

Elevating Equipment

The free-flowing characteristic of small grains and pellets permits both vertical and horizontal movement. Some devices, such as the screw or auger, can be used at any elevating angle. Others are best suited for vertical or horizontal operation only. Still other devices, such as the chain and flight conveyor, are practical at angles from horizontal to a maximum of about 45 degrees.

Centrifugal-Discharge Bucket Elevator

The bucket elevator is the most efficient means of producing vertical movement of free-flowing materials, and the centrifugal-discharge elevator is the most common type. In this type of elevator, buckets are uniformly spaced on a belt or chain to prevent interference when discharging. Material is discharged by centrifugal force at the head. It is picked up by direct loading into the buckets and by scooping from the boot at the foot of the elevator. Figure 1 shows the relationship between the head wheel speed and the radius of the path of the centre of gravity of the material in the bucket for satisfactory discharge at high and moderate elevator speeds.

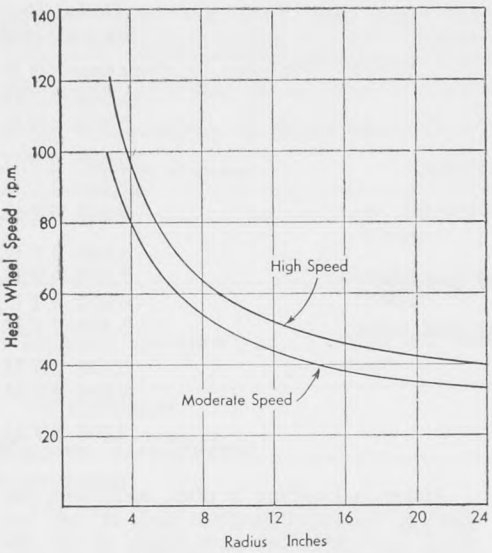


Figure 1

The speeds and diameters of head wheels for high-speed centrifugal-discharge elevators are not satisfactory for handling light dusty materials such as ground feeds. The wheel speeds may be reduced by 80 percent as shown by the moderate speed curve in Fig 1. This reduction in speed will reduce the dust problem and provide better pickup.

Elevator Capacity

The capacity of a bucket is considered to be from 85 to 90 percent of the struck volume for high speed, if the feed is arranged to allow loading at or above the center of the foot shaft. If loading is below this point, the capacity may be reduced to 80 per cent of the struck volume. On moderate speed elevators, the bucket should be expected to fill 90 per cent of its struck volume.

Elevator capacity may be calculated as follows:

$$\text{Elevator Capacity (lb per min)} = \frac{\text{Bucket Capacity (lb.)} \times \text{Belt speed (fpm)}}{\text{Bucket Spacing (ft)}}$$

Elevator Horsepower

In practice, theoretical horsepower required to lift the material needs to be increased only 10 to 15 percent to obtain the actual power requirement. Theoretical horsepower may be calculated as follows:

$$\text{Horsepower} = \frac{\text{Elevator Capacity (lb per min)} \times \text{Height (ft)}}{33{,}000 \text{ ft-lb per min}}$$

It is advisable, in determining horsepower, to use the struck volume of each bucket in determining the elevator capacity. This will eliminate power failures where feed rate is high and the buckets are filling well above the center of the foot wheel.

The auger or screw conveyor, in which the auger is contained within a cylindrical tube, has been used extensively for both conveying and elevating free-flowing materials. Some general conclusions regarding auger conveyors follow:

Maximum capacities occur between 700 and 900 rpm for 6-in diameter augers and at speeds over 1,000 rpm for 4-in augers.

The capacity in a vertical position is from one-third to two fifths the capacity in the horizontal position.

Horsepower requirement increases directly with speed from 300 to 1,000 r.p.m. and varies with the type of material elevated.

Maximum horsepower is required at elevating angles of 50 to 60 degrees. Maximum elevating efficiency also occurs at these angles.

Auger length has no effect on auger capacity nor on the horsepower required per foot of length.

Gravity Flow of Granular Materials

Granular materials, such as small grains and pellets, are generally considered to be free-flowing. However, in the presence of dust, cracked material and excessive moisture, such material may show a reluctance to flow. Reluctance of some granular materials to flow increases the difficulty of designing handling systems. This problem can be eased by application of some of the following principles.

Compaction caused by combination of bin pressures, impact on filling and vibration is generally responsible for arching or bridging at the discharge point. This compaction may be reduced in a number of ways. Bin pressure in the main portion of the bin may be reduced by installing a criss-cross partition, i.e. two partitions at right angles to each other at the center of the bin. Another method of reducing bin pressures is to use continuous ledges around the side walls at vertical intervals. Shelves hung at intervals in the center of the bin have the same effect.

When a hopper is used at the bottom of the bin, bridging may occur. The Board of Coal Research has successfully overcome this problem in bins for granulated coal by incorporating the device shown in figure 2. A large top opening, which encourages flow, is reduced to a small opening suitable for delivery by passing the material over a cone.

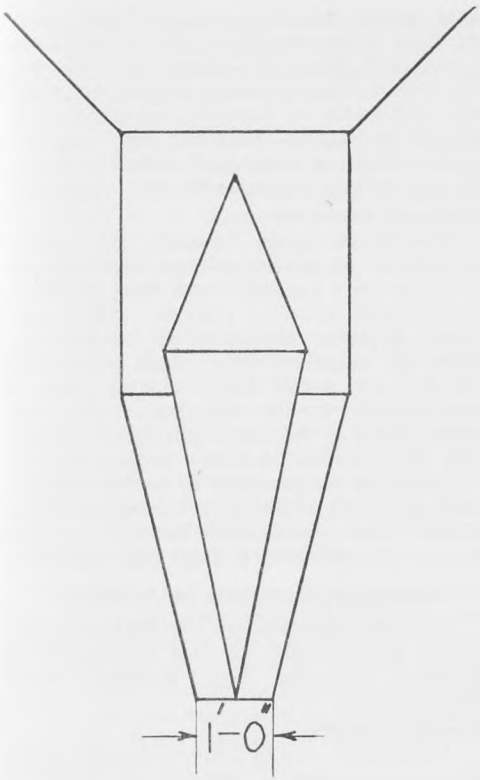


Figure 2

Metering Devices

Meters are used to regulate flow. e.g. when it is desired to grind two or more grains in fixed proportions. The flow of each grain to the grinder can be regulated by a meter. Three types of meters are in general use for continuous measurement as against batch measuring. The first is the belt meter which covers the floor of a storage bin and is suitable for even non-free-flow material. When the material to be metered flows more freely, auger meters and vibrator meters can be used. The auger meter is simply an auger in which the capacity is regulated by varying the auger speed.

The vibrator meter consists of a box with a trough on one side that extends out several inches and an electrical vibrator attached to the bottom of the trough. The trough of the vibrator is sloped a few degrees below the horizontal and this imparts a forward movement to the material as the meter is vibrated. The usual method of regulating capacity is to control either the gate opening into the trough or the vibrator voltage. Quite often the gate is used for approximate setting, while the voltage is controlled for close adjustment. Fig. 3 shows a vibrator meter.

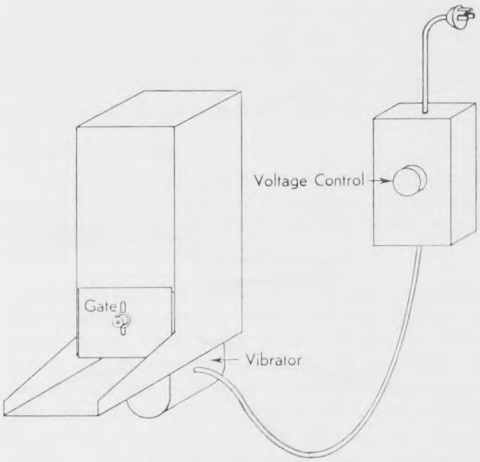
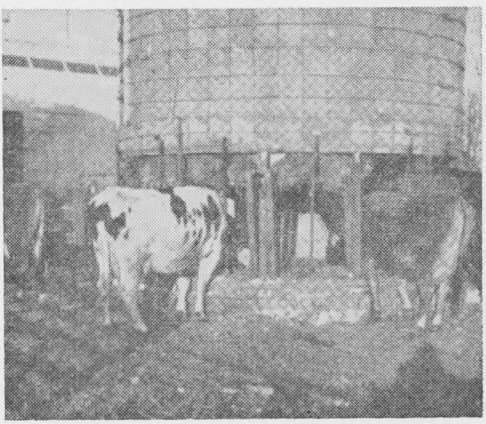


Figure 3

HANDLING NON-FLOW MATERIALS

Fibrous Material

A fibrous material, such as chopped hay or silage, is most unlike a granular material, does show some tendency to flow. Attempts to cause fibrous material to flow by piercing and separating it with a penetrating cone have usually failed. A constricting ring placed near the bottom of a vertical bin is better. Figure 4 shows a roughage bin with a constricted section at the bottom. When a distributing cone is located some distance below the restriction in such a bin, silage or cut feed may be self fed.



Proper filling of bins is important. Applying the cut material around the perimeter of the bin is very desirable if self-emptying is to be attempted later. Figure 5 illustrates this method of filling.

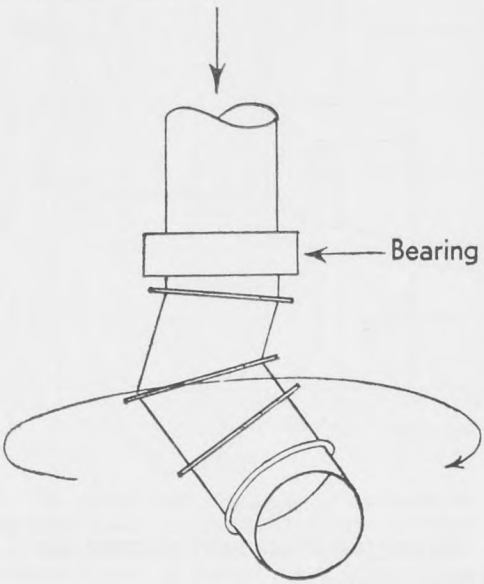


Figure 5

Unit Loads and Stacks

The fork lift truck has had a great impact on industrial materials handling. In the past, batches of material were sized so that a man could lift and move them. The advent of the fork lift has resulted in increasing the size of the batches or unit loads to a practical size for the fork lifts. Common sizes are 4'x4' pallets for materials which can be stacked and 20 bushel bins for bulk materials.

Fork-lift trucks, combined with 20 bushel bins, are being used extensively in apple harvesting and processing. Pickers empty their buckets into the bins. The bins are carried by fork-lifts to flatbed trailers. Orchard fork-lifts usually consist of both front and rear fork-lift units mounted on an agricultural tractor. Removal of the gins from the trailer at the processing plant is also by fork-lift. The possibility of a similar principal being used to handle baled hay is suggested. If bales were tied or otherwise handled in units of 9 or 12, an economic unit load for mechanical handling would be available.

The word "stack" as used in farming generally refers to a bulk of material piled outdoors and so large that it cannot be moved in one load. In the case of hay, the recently introduced stack mover has altered this concept. The combination of sweep stackers for stacking, stack mover for transport and grapple fork or self feeding for removing hay from the stack presents an economical method of handling and feeding forage under some conditions.

Roughage Conveyors

The farmer should remember the cardinal principle of materials handling: **"Don't handle it if you don't have to."** Self feeding should be employed wherever possible. Where conveying becomes necessary, as in stanchion barns, the auger conveyor, chain and paddle conveyor and the 45 degree manger conveyor are available. Forage and silage feeders, employing each of the above principles, together with provision for metering concentrate and minerals into the conveyor to be fed with the roughage, are available from commercial firms, or have been assembled by farmers. It is estimated that 75% employ auger type conveyors.

HANDLING LIQUID MATERIALS

The two considerations involved are transporting and metering. In some installations, as sprinkler irrigation, both problems occur simultaneously.

Liquid Transport

Liquids are usually moved through pipes. Flow occurs when a pressure or "head" is applied to the liquid by means of a pump or by a difference in elevation. The rate of flow is determined by the head and by the resistance or friction offered by the pipe to the flow. The resistance to liquid flow increases with reduction in pipe size, so if the pipe size is too small, a very high pressure is required to obtain a desired flow. Table I shows friction head in pipes carrying water.

Table I

The power to overcome this friction is usually supplied by a pump. The theoretical power required to pump liquid through a pipe can be calculated as follows:

$$H.P. = \frac{\text{lb. Liquid Pumped per min x Total Head in ft.}}{33{,}000}$$

where the total head may be made up from:

(1) difference in elevation between the inlet level and the discharge point.
(2) friction head (see Table I).
(3) head required at the discharge end. For free discharge, head at discharge end is nearly zero, while for a sprinkler for instance, head required at the inlet to the sprinkler may be 100 feet or more (1 psi=2.31 feet of head).

Actual horsepower may be from 20 percent to more than 100 percent higher than the theoretical horsepower, depending upon the efficiency of the pump and drive.

Pump Types — The selection of a pump should be based on the head required together with other factors such as the properiets of the liquid to be pumped. Factors such as abrasive and corrosive properties and liquid viscosity are most important in selecting a pump for a particular job.

Centrifugal Pump is widely used for pumping water, milk, lubricants and chemical solutions. It is relatively simple, has high mechanical efficiency under favourable conditions, and can handle fluids containing solids in suspension. Disadvantages are that it is not self-priming, unless specially equipped, and high pressures cannot be obtained with single stage pumps. The centrifugal pump is used almost universally for sprinkler irrigation.

Gear Pumps are positive displacement units and are quite inexpensive and simply constructed. The chief disadvantage is that abrasive particles which may be present in the liquid quickly destroy the close tolerances that are necessary for the pumps to develop normal pressures. Gear pumps are not suitable for pumping wettable powders.

Vane Pumps have similar characteristics and limitations to gear types. Recently, metal vanes have been replaced by nylon rollers or vanes. This change has greatly increased the resistance to abrasion. For this reason, vane pumps with nylon rollers are now widely used for sprayer application.

Piston and Plunger Pumps are usually employed where pressure higher than that readily obtained with a rotary pump is desired. The barrels and plungers are subject to scoring by abrasive particles. Adaptability has been greatly increased by the use of ceramic barrels and nylon plungers. Pumps so equipped may be satisfactorily used for pumping liquids containing abrasive particles.

Diaphragm Pumps have been used for many years for pumping materials containing a large proportion of solids, such as liquid manure. Recently they have been designed with metal diaphrams making it possible to use them at moderately high pressures. Tests have indicated that the life of this type of pump is many times that of rotary pumps when used for pumping such abrasive materials as wettable powders.

Helical Screw Pumps have shown that they are quite suitable for pumping manure, even in a semi-solid state. Liquid manure has also been successfully pumped from storage sumps into tank wagons by ordinary grain augers.

Corrosion — For chemicals, use pumps that are constructed from materials that do not corrode with the particular chemical. Chemical suppliers should be able to furnish information on suitable pump materials for their chemicals.

Liquid Metering

Liquid handling, such as application of liquid fertilizers and soil fumigants, or molasses feeding or crop spraying, require liquid application at a controlled rate.

Liquid may be metered through a positive displacement pump, either of the piston or rotary type. For each piston stroke or revolution of the rotor, a definite quantity of liquid will be delivered. Delivery rate varies with the number of piston strokes per minute or of the revolutions per minute of rotary types. With piston pumps, the application rate can also be altered in some instances by changing the pump stroke. This metering principle is used extensively on field applicators, with the pump driven directly from the ground wheel.

The rate of flow of a particular liquid through an opening or orifice is determined by the size of the opening and the pressure, or head, applied to the liquid, according to the following relationship:

$$\text{Flow} = K\ A\sqrt{P}$$

Where K = a constant, determined by the properties of the liquid and the orifice.

A = the area of the orifice.

P = the pressure applied.

It can be seen from this equation that the flow for a particular liquid varies directly as the area of the opening and as the square root of the pressure applied. Doubling the area of the opening doubles the flow, while doubling the pressure increases the flow by only 41%.

The principle of an orifice is widely used in liquid metering. The pressure is often the most convenient variable so that metering is controlled by varying the pressure. Methods of varying the pressure include changing the elevation of the liquid container in a gravity system, pressurizing the liquid by means of a

pump equipped with a pressure-limiting valve, and pressurizing the liquid tank by means of an air compressor. All of these principles are readily adapted to the metering of liquids commonly used in farming.

Where viscosity changes appreciably with temperature as with molasses or lubricating oil, the rate of flow also changes with temperature. When these are to be metered through an orifice, some temperature readily reproducible, such as room temperature, should be selected.

REFERENCES

Because principles of materials handling are relatively new to Agriculture, there are few bulletins. A list of textbooks dealing with this subject has been compiled and copies of the list are available on request from:

The Department of Agricultural Engineering, University of Alberta, Edmonton.

Extension Engineer, Department of Agriculture, Edmonton.

Korven Irrigation Leaflet.

Experimental Farm, Swift Current, Sask.

TABLE I

Frictional Resistance to Flow of Water

FRICTIONAL RESISTANCE IN FEET OF HEAD PER 100 FEET OF PIPE

Rate of flow Imp. gallons per minute	Sizes of pipe in inches							
	½"	¾"	1"	1¼"	1½"	2"	2½"	3"
1	5.2	0.7	0.2					
2	18.6	2.5	0.6	0.2				
3		8.8	2.1	0.7	0.3			
4		13.3	3.1	0.1	0.4	0.1		
5		18.6	4.4	1.5	0.6	0.2		
8			11.2	3.8	1.5	0.4		
10			15.6	5.3	2.2	0.5		
15			33.0	11.3	4.6	1.2	0.4	
20				20.6	8.4	2.1	0.7	0.3
25				29.0	11.7	2.9	1.0	0.4
30				38.5	15.5	3.9	1.3	0.5
35					21.0	5.5	1.9	0.8
40					30.0	7.5	2.5	1.0
65						15.8	5.3	2.2
85						27.0	8.9	3.7

NOTE: The friction in a 90° elbow is approximately equal to the friction in 10 ft. of straight pipe.
This table is for galvanized iron pipe. Smoother pipes have lower values of frictional resistance.

Self-feeding upright. Experimental self-feeding upright silos have been perfected at Michigan State College (above) and Rutgers University. Secret is to support the mass in silo. Some handwork is needed to adjust supports which regulate silage flow.

Farm Management

The science of management is difficult to define. Yet the ability to manage must be important, because some individuals become successful in their businesses, while others, with similar resources do poorly, or fail completely. Some do not take the time, or lack the ability and patience to weigh alternative courses of action, from the view of risk, profit, opportunity, and feasibility.

Farm management deals with the organization and operation of a farm with a view to the greatest continuous profit. It places the operation of a farm on a business basis, producing at the lowest cost and selling to best advantage.

Farm management deals with the processes of making sound decisions, using proven economic laws and principles.

Sound decision making involves the following steps all of which are necessary:

1. Recognizing the basic problem.
2. Looking for the alternative solution.
3. Analyzing to select the best solution.
4. Taking action on the selected alternative.
5. Bearing the responsibility of the outcome.

This section deals with some of the tools of sound business, management, namely:

1. Farm Records
2. Farm Business Analysis
3. Budgeting

Also included are sections on Farm Leasing Arrangements, Marketing and Market Cycles, Credit Sources, and definitions of some commonly used terms.

Farm Records

Farm records are not an end in themselves. They are however, an indispensible link in the chain of business practices leading toward better planning, and more effective use of farm resources.

A recording system will give a simple but accurate "figure picture" of the farm business, in dollars and cents, and should include such information as crop and livestock yields, feed, and other physical records. Facts concerning past performance lead to better decisions for the future.

The principle purposes of farm records are:

1. **To give a history of performance of the farm.** A complete record over the years shows the operator whether or not he is increasing the financial status of his business. An increasing yearly net worth statement shows that his assets have outgrown his liabilities. A declining net worth statement is a warning for him to stop and seriously examine his operations. A well prepared operating (profit and loss) statement will help him analyze happenings between annual "net worth" calculations.

2. **To aid in the control of current operations.** Current farm records tell how the business is conforming to plans or budgets set up for it. In many businesses outside of agriculture, monthly analyses keep a constant check of the operations. Even the busy farmer should insist on periodic checks of his business. Prompt detection of weak points may prevent serious losses.

3. **To provide basic information for future production plans.** Farmers, like other business men, need reliable and practical information in making plans for next month, next year, or even five years from now. They need it for small adjustments, or for major changes. Records give needed information on cost and price relationships, crop yields, rates of gain, butterfat production, etc. Such data are necessary for accurate budgeting, since estimates may be quite inaccurate.

4. **To provide detailed information for income tax filing.** Without records small items of expense are forgotten and these can add up to a considerable sum over the year. A systematic farm account makes the task of filing income tax returns much easier. The tin can, or shoebox file requires a great deal of sorting at the end of the year, and chances are that bills were not received to cover all of the year's transactions. Discrepancies usually lead toward overestimation of taxable income.

Two basic financial statements which every farmer should complete are:

1. Net Worth Statement. (Balance Sheet)
2. Operating Statement (Profit and Loss)

NOTE—Most forms referred to are included in good farm account books. Others are obtainable from Department of Agriculture, Edmonton. See your District Agriculturist.

A Net Worth Statement or Balance Sheet is a statement of the balance between the farm operators assets (what he owns) and his liabilities (what he owes against his assets) at a particular point of time, usually at the end of the calender year. It gives an appraisal of the operators equity in the business. If it includes personal assets and liabilities, it will indicate his net worth. The formula used is — Total assets equals liabilities plus operators net worth. The net worth or balance sheet is a "snapshot" of the operators business

affairs at a particular point of time. This is the type of statement bankers demand when a loan is requested. Net worth statements tell the farm operator three basic things:-

1. The kind and amount of his assets and liabilities.
2. The amount of equity he has in the business.
3. The increase or decrease in his equity from one net worth statement to the next.

FARM AND OPERATOR'S NET WORTH STATEMENT AS AT ..... 19.....
(Form 1)

Assets (Property Owned)	Value Beg. of Year $	Value End of Year $	Liabilities (Debts Owed)	Value Beg. of Year $	Value End of Year $
Cultivated land acres			First farm mortgage		
Uncultivated land acres			Second Farm Mortgage		
Farm Bldg. & Improvements			Farm chattel mortgage		
Livestock and Poultry			Farm notes payable		
			Farm accounts payable		
Farm Machinery and Equipment			TOTAL FARM LIABILITIES (2)		
			FARM NET WORTH (3)		
Hay, grain, farm supplies			(1) minus (2)		
			Change farm net worth		
Farm accts. receivable			during year XXX		
			Other assets (4)		
			(Personal, household & other non farm)		
Cash in bank or on hand			(Co-op & other shares)		
			Other Liabilities (5)		
			(Personal, household & other non farm)		
			OPERATOR'S TOTAL NET WORTH		
			(3) plus (4) minus (5)		
			Change of oper. total		
TOTAL FARM ASSETS (1)			NET WORTH DURING YR		

Operating or Profit and Loss Statement: - While a net worth statement tells the operator where he stands on a certain day, the operating statement explains how he got there. It fills in the gaps between net worth statements, and measures his efficiency. If the net worth statement is a still snapshot, the Operating Statement is a moving picture type of summary. The accumulation of information required to prepare an operating statement constitutes what most farm operators consider as bookkeeping. The majority pay their income tax as assessed from a "cash operating statement," but a few may elect to file on the accrual basis. Where a rise in inventories is added to income, while a drop is considered an expense. The accrual method gives a truer picture of farm operating expenses (input) and farm operating receipts (output) Thus the accrual or inventory method is most satisfactory for farm management work, regardless of which system is used for income tax filing.

Two Necessary Steps

Steps in farm accounting to accumulate information for a true operating statement are:

STEP (1) At the beginning of the accounting period, usually January 1st, list the inventories of farm assets showing type of asset, and the appraised present market value. The present market value as determined at the time of inventory is often a more realistic value to the owner than using an artificial depreciation percentage rate, or income tax rates which often do not reflect the true present market value to the owner.

Below is shown a simplified example dealing with opening, and closing inventories.

(Form 2) **OPERATOR'S FARM INVENTORY**

Land and Bldgs.	Value Beg. of Year	End of Year	Livestock	Value Beg. of Year	End of Year
TOTAL			TOTAL		
Farm Machinery			**Supplies & Produce**		
TOTAL			TOTAL		

STEP (2) List the farm business expenses and receipts as they occur throughout the year. One should differentiate between Capital expenses which are assets lasting for several years, e.g. buildings, machinery, and in certain cases tires or tools, and operating expenses, i.e. items which are used up within the accounting year, such as seed, gas, oil, and repairs (unless they are major repairs which add substantially to the value of the implement). There is no fixed line between the two types of expenses, but they affect the Profit and Loss appraisal differently. Similarly it is necessary to separate capital sales of equipment or real estate from operating receipts of farm production such as crops or livestock.

(Form 3) **FARM EXPENSES**

Date	Number or Amount	Description of Item	1 Total Value	2 Cattle Exp.	3 Poultry Exp.	4 etc.
		Totals Brought Forward				
		Totals Carried Forward				

(Form 4) **FARM RECEIPTS**

Date	Number or Amount	Description of Item	1 Total Value	2 Milk & Cream Receipt	3 Other Cattle Receipt	4 etc.
		Totals Brought Forward				

Column headings are flexible and should be set up to be of most use to the farmer concerned.

STEP (3) At the end of the year, close the transactions with a closing inventory (beside the opening inventory for ease of compilation and comparison). See Form 2 — "Operators Farm Inventory."

STEP (4) Summarize the year's business and prepare an operating or Profit and Loss statement to find net income, labor earnings to the operator, and return on farm investment. This is also the logical time to prepare a new Net Worth Statement.

Form 5 represents one basic operating statement, but there are several forms available. Many operators prefer to show depreciation as a separate expense, instead of having it absorbed in inventory change and purchases and sales of capital equipment, as is the case in the form shown here. This can be done without changing the final profit answer, by omitting sales, purchases and inventory change of buildings and equipment, and instead, adding as an expense the amount of depreciation taken for the year.

The foregoing steps comprise the basic requirements for preparing the two main financial statements, namely the Net Worth or Balance Sheet, and the Operating or Profit and Loss statement. These, together with physical records on crop and livestock yields, feed and labour usage, provide information for analysis of the farm business, and for budgeting and income tax.

(Form 5) **SUMMARY OF THE FARM BUSINESS FOR THE YEAR**

Summary of Farm Inventories	Beg. of Year	End of Year
Land and Buildings		
Livestock & Poultry		
Farm Mach. & Equip.		
Supplies & Produce		
TOTAL FARM INVENTORIES		
Decrease in Farm Inventory		
Increase in Farm Inventory		
Average Farm Inventory		

Summary of Farm Expenses	Amount
Cattle	
Poultry	
Hogs	
Automobile (Farm Share)	
Trucks	
Tractors	
Combine	
Other Equipment	
Small Tools & Hardware	
Farm Home	
Other Farm Bldgs. & Fences	
Crops	
Labor & Board	
Miscellaneous	
Rental Payments to Landlord	
Capital Purch. & Improv.	
TOTAL CASH FARM EXPENSE (2)	
Decrease in farm Inventory	
Value of Unpaid Family Lab.	
TOTAL FARM EXPENSE (4)	

Summary of Farm Receipts	Amount
Milk & Cream	
Other Cattle Receipts	
Poultry	
Hogs	
Grain to Landlord	
Wheat	
Oats	
Barley	
Rye	
Flax	
Other Crops	
Fruit and Vegetables	
Wheat Board Payments	
Dividends & Bonuses	
Miscellaneous	
Capital Sales	
TOTAL CASH FARM RECEIPTS (1)	
Increase in Farm Inventory	
TOTAL FARM RECEIPTS (3)	

Summary of Farm Income	
NET CASH FARM INCOME (5)	
(1) minus (2)	
TOTAL FARM INCOME (6)	
(3) minus (4)	
A. (To calc. oper's labor Income)	
INTEREST ON FARM INVEST. (7)	
(5% of Aver. farm Inven.)	
OPERATOR'S LABOR INCOME (8)	
(6) minus (7)	
B. (To calc. % return on capital)	
OPERATOR'S WAGE ALLOW. (9)	
RETURN ON CAPITAL (10)	
(6) minus (9)	
PERCENT RETURN ON CAPITAL (11)	
(10) times 100 divided by aver. farm investment	

Analysis Of Managment Factors

Analysis of the year's business is the next step in the farm management process. Farm records are a guide during the year in making management decisions, and annual analyses at year-end disclose weak and strong spots, as they relate to profit.

Some factors affecting earnings are very important, others are less significant. Some are beyond control of an individual farmer while others can be regulated through sound business management. A successful farm is one that pays all expenses and yields the farm family a good living over a long period of time.

Farm Receipts

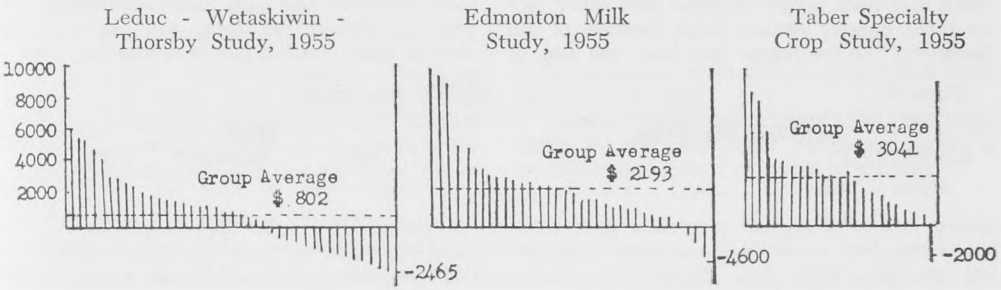
Generally speaking, farm receipts should be sufficient to:-

a: pay all cash operating expenses;
b: provide for depreciation of equipment;
c: take care of land conservation necessary to maintain incomes over a long period of time.
d: provide a fair interest return on farmer's farm investment.
e: provide a wage for farm work done by farmer's family.
f: leave a residual to the farmer for his work and management.

Farm management studies in Alberta indicate that many farmers in every district attain these income requirements. Many do not, even with similar weather, soil and price conditions.

THREE SETS OF GRAPHS SHOWING RANGES IN OPERATORS ANNUAL LABOUR EARNING BETWEEN FARMS UNDER STUDY.

(each bar represents the labour earnings of a farm under study)



Land, labor, capital, and managerial ability are the resources of the farm operator. Wide differences between farms in the amounts and proportions of these resources cause profits to vary from farm to farm. Farm business analysis attempts to measure the efficiency with which each of these productive factors is being used, and to indicate methods of improving their overall effectiveness.

The Vital Factors

Farm management studies in Canada and other countries indicate that differences between incomes on farms in similar areas are associated with:

1. Size of business, or acres of crops and number of animals.
2. Use of labor, or output per man.
3. Use of capital, or turnover on investment.
4. Crop returns per acre.
5. Livestock returns per animal.
6. Enterprise combinations, or lines of production.

Local studies in Alberta show clearly that it is not always good land or large acreage that puts a farmer in the high income group. Some of the higher income farms on these studies were on only medium quality soils, while some smaller farms made higher incomes than some of the larger ones. Neither did those with the most livestock, or any certain type of livestock, always make the most money. Best results were obtained by that group of farmers who had favorable balances between, and who gave equal importance to all the six factors listed above. Farmers who were at least average or better in these factors made as much as $5,000 to $6,000 more per year than those who were below average for the district in all six items. For each of the six factors

in which a farmer was average or better, approximately $500 to $1,000 was added to his net income. Thus it is more important to bring all of these factors up to at least average for the district than to bring any one of them alone to a very high degree of efficiency. Once average levels have been attained in all, the next objective should be to raise all to above average levels.

These six major profit-promoting factors can be referred to as "THE BIG SIX" in Farm business management analysis. A farm business with widely differing levels of efficiency in the six items is described as "being out of balance." Equal degrees of efficiency place a farm "in balance" from the standpoint of good management.

The first concern in farm business analysis is to compare the operation to predetermined district standards in these factors.

Business Size and Labor Efficiency Analysis

Although acres is the usual measure of size, it is not very suitable where livestock is a big part of the farm business. A quarter section farm may be a bigger business than other half or three quarter section farms because of the livestock. To overcome this bias, the use of the "Productive Man Work Unit" is one of the better methods of measuring the size and labour efficiency factors. A "productive man work unit" is a unit of measurement of work. It represents the average amount of directly productive work accomplished by one man under average farm conditions, in a ten hour day. By directly productive work is meant work which increases output in the same year it was expanded. It does not include work which is productive only in the longer run such as clearing, fallowing or breaking land. The number of productive man work units on a farm is calculated by multiplying the number of acres in each crop, and the number of each kind of livestock, by units which have been established on the basis of the average amount of time to handle to one acre, or animal on a large sample of farms.

Completing the following calculations will show a farm operator whether he is above or below district averages in size of farm business, and productive accomplishment per man. Other measures often used in assessing farm business size and labor efficiency, are total investment per farm and per man, as well as gross receipts per farm and per man.

(Form 6) PMWU Per Farm:

PMWU Per Farm	No.		Work Standard*		PMWU
LIVESTOCK:					
Cows - Dairy	_____	x	12.0	=	_____
Beef	_____	x	3.0	=	_____
Herd Sire	_____	x	5.0	=	_____
Two-year olds	_____	x	2.0	=	_____
Yearlings	_____	x	2.0	=	_____
Calves	_____	x	1.0	=	_____
Sows	_____	x	3.5	=	_____
Hogs Raised	_____	x	0.7	=	_____
Sheep	_____	x	0.5	=	_____
Poultry (mature)	_____	x	0.2	=	_____
Poultry (turkeys raised this year)	_____	x	0.3	=	_____
(chickens raised this year)	_____	x	0.1	=	_____
CROPS:	Acres				
Small grains	_____	x	0.8	=	_____
Hay crops	_____	x	1.0	=	_____
Potatoes, root crops	_____	x	7.5	=	_____
Canning corn	_____	x	4.5	=	_____
Canning and Shelled peas	_____	x	2.5	=	_____
Beans, Cukes, Tomatoes	_____	x	12.0	=	_____
Custom work (done by me)					
No. of days	_____	x	1.0	=	_____
Days worked out	_____	x	1.0	=	_____
Total PMWU					_____

LABOUR FORCE:	Months Worked
Operator	
Family	
Hired	
Total months labour	

Man equivalents = Total months labour / 12 = ____ / 12 =

Work units per man = Total PMWU / Man equivalents = ____ =

°Subject to Revision

Using these work standards, suggested Alberta farming areas, (as determined from average farm size and average labor accom- studies and other local information) should be plishment per man for the different types of approximately as follows:-

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	Size in PMWU °	PMWU per man °
Fluid milk farms	700	325
Parkland Mixed farming	450	300
Prairie Wheat farming	500	350
Irrigation Specialty crop farming	650	275
Irrigation mixed farming	350	250
Fringe area mixed farming	350	250

° Appraised from provincial, dominion studies, and other local information across Alberta. Individual experience may indicate that local pockets or farm groups within the above broad breakdowns can be more accurately appraised from levels established from reliable local data.

Farms substantially lower than the standards in size and labor efficiency forfeit a considerable amount of profit as a result.

Measuring Overall Capital Efficiency

Rising wages and shortage of a farm labor has forced expensive farm mechanization. This has solved some farm problems, but has created others. On many farms the investment in machinery and buildings now exceeds that of land. While it has increased the output per worker, mechanization has introduced a new rigidity in the farm costs by altering and increasing the number and size of the expenses. It is therefore important not to exceed safe economic limits in substituting capital for labour. Every business including farming has a necessary rate of turnover on capital. Farmers whose gross yearly farm receipts would equal the total farm investment in 3 to 4 years are average in capital efficiency. Some do this in as little as 2 years while others take 8 or more years. Such low rate of turnover could be due partly to over investment for the size of farm business, or to inadequate returns per animal, or acre.

Measuring Crop Efficiency

Most operators are conscious of the loss that can result from low crop yields. It is not so easy to assess in dollars and cents how the total crop enterprise compares to the district average, because, of different proportions of wheat, oats, barley and other crops in the program. The "crop index" method assesses the success of the cropping program.

Crop index is a percentage comparison of crop yields to the district average. It considers the weighted effect to all the crops, and not just the best field which had the most fertilizer, or other favorable treatment. On most farms it can be measured by calculating a weighted average of all physical crop yields. In cases where certain crops grown are more valuable per acre than others (e.g. flax, sugar beets, corn), it is better to use a monetary comparison, because low yield of a high value crop is more serious than in a lower valued one, e.g. cereal. This applies mainly to irrigated areas where specialty crops are grown. Under this system "crop index" is the value of the total crop as compared to its value if district average yields have been obtained. It is expressed as a percentage of the average. The following form will serve as a guide for the farmer wishing to rate his crops on a "crop index" basis.

(Form 7)

Crops Grown	Acres	Total Yield	Value per bu. or ton	Total Value of Crop	District Yield per Acre	Total Yield if ave. Yields Obtained	Total Value of Crop if Aver. Yield Obtained
TOTALS		XXXX	XXXX	y)	XXXX	XXXX	z)

YOUR CROP INDEX will be (y) divided by (z) times 100%, or ——% of district average, where the average crop index for the district is rated at 100%.

Measuring Livestock Efficiency

Completion of a form similar to the following should give a good "dollars and cents" working knowledge of livestock yield compared to district standards. Low livestock yields on a livestock farm can mean thousands of dollars loss in income. For example, some fluid milk operators are producing only 5000 lbs. of milk per cow as compared to others at 12,000 - 13,000 lbs. per cow, a difference in value of over $300. per cow per year.

This calculation will give you a weighted appraisal of the production rate of your livestock. It is a percentage calculation of the overall value of your livestock production rate, as compared to the value at average production standards. The totals are not necessarily the total value of livestock production on your farm for the year. This would require details involving livestock inventory, sales and purchases. It does give you an appraisal of your livestock income advantage or disadvantage in relation to district standards by being better than, or lower than average, whichever the case may be. It gives a "weighting" to all your livestock yield rates. Weighted comparisons are a better measure than assessing each type of livestock separately, because low yield in a relatively large, or perhaps a high value livestock enterprise is more serious than in a less important livestock project on your farm.

Type of Livestock	Number on your Farm	Production Rate per Animal	Total Production	Value per Unit	Total Value of Production	Standard or Ave. Yield Rates per Animal	Total Value if Average Yields Obtained	Total Value of Production if Av. Yield Obt.
Dairy Cows Kept		lbs.	lbs.			250 lbs. B.F. or 8000 lbs. milk/yr.	lbs.	
Brood sows kept		lbs.	lbs.			14 hogs raised per sow per yr.	lbs.	
Steers on feed for ..... days		hogs.	hogs			2 lb. per day on full feed	hogs	
Laying hens kept		doz.	doz.			14 doz per yr. or 50% lay in winter	doz.	
Ewe flock kept		lambs	lambs			1.3 lambs per ewe	lambs	
Total Values	XXXX	XXXX	XXXX	XXXX	(A)	XXXX	XXXX	(B)

Your livestock production rate index will be the total (A) divided by the total (B) times 100% equals .....%.

An index of less than 100% indicates that your livestock production rate per animal is below the district average, while an index of over 100% shows you are exceeding average performance rates. District average is not a high standard and yields above average would increase farm profits unless money available for improvement is needed more urgently for improvement of other factors in the farm business. **Note:**—You can use blank lines above to assess production rate of livestock not listed.

Selection of Enterprise Combinations

There is no simple measure of effect of enterprise combinations on farm earnings which would be suitable for any one farm. Important items to consider in selecting a combination of enterprises on any farm are:

(1) Relative profitability of different enterprises;

(2) soil type and the amounts of tillable and untillable land;

(3) the effect on labour distribution throughout the year;

(4) farm size and location in relation to special markets;

(5) to a certain extent the preferences of the operator.

Farm business studies show that enterprise combinations limit possible farm income when:

(1) an enterprise contributes less than 20% to cash income;

(2) when there are more than two livestock enterprises in addition to the usual crop enterprise;

(3) when the enterprises compete seriously for the farmers management and labour at peak seasons;

(4) when a more profitable enterprise or combination of enterprises suitable for the district and soil type is being ignored.

Too many enterprises usually means that management will be spread too thinly to be effective. Also, a large number of enterprises on a typical size of farm means that one or more of them will be too small to mechanize adequately. A small enterprise may contribute very little to receipts in relation to the extra expense and labor involved.

Budgeting

Budgeting is simply the planning stage of farming. The farmer who is alert will spend considerable time making and revising plans and examining various crop and livestock systems and practices. From these he will select the ones which promise the best income from the business as a whole over a period of years. Many operators make no formal or written plans, but estimate in a rough way and count on working out the details as they occur. The man with considerable experience and skill can plan or budget in this manner, especially for a simple business. The young farmer with limited experience needs a more definite plan. Any farmer could well afford to do some formal figuring under present changing conditions.

The important objective of budgeting is to compare alternative plans for prospective profit. The goal is not merely one of setting down a single plan to be followed without deviation. The real purpose is to figure out which of several business alternatives promise the best profit. It may be necessary to work out alternative budgets to see which will use the farm families resources to best advantage. Once a decision has been made the written budget can be very useful in checking actual progress against that anticipated.

Two General Types

Two types of budgets are commonly used: (a) complete budget (b) partial budget. The complete budget is used for estimating total returns and total costs for the whole farm business. The partial budget is useful for planning small changes within the business, e.g. adding a livestock enterprise, or purchasing equipment. The partial budget is an attempt to measure the costs and returns from a change of part of the farm business. Whatever the type of budget the goal is to make better use of resources.

(Form 9)

Estimated change in Annual Net Farm Income from the proposed change of .....

.....

Additional Annual Costs Expected

1. **Fixed Costs**

Depreciation ..... $.....

Interest ....

Insurance ....

Taxes ....

Others ....

2. **Operating Costs**

Labor ....

Repairs ....

Feed ....

Fuel ....

Electricity ....

Other ....

Reduced Annual Receipts Expected ....

Sub-Total (A) ..... $.....

Additional Annual Receipts Expected ..... $.....

Reduced Annual Costs Expected

1. **Fixed Costs** ....

2. **Operating Costs** ....

Sub-Total (B) ..... $.....

Estimated change in Annual Net Farm Income (B-A) ..... $.....

OTHER CONSIDERATION

Extra Capital Needed ..... Degree of Risk .....

Extra Labor to Hire ..... Time lag till income starts .....

Other Advantages of Proposed Change	Other Disadvantages of Proposed Change
1.	1. .....
2.	2. .....
3.	3. .....

(Form 10)

THE FARM BUDGET
Estimated Expenses

I Operating Expenses	Expended Past Yr. $	Estimated Next Yr. $
Crops		
Livestock		
Livestock		
Poultry		
Gas, Oil, Grease		
Machinery Maintenance and Repair		
Building Maintenance and Repair		
Farm Truck		
Hired Labour and Custom Work		
General		
Miscellaneous		
Automobile (Farm share)		
Operating Expense Totals		
II Captal Expenses		
Land		
Buildings		
Machinery and Equipment		
Capital Expense Totals		
Total estimated Expenditures		

Estimated Receipts

III Cash Receipts	Received Past Yr. $	Estimated Next Yr. $
Crop Sales (state kind)		
Livestock Sales		
Livestock Products		
Miscellaneous Receipts		
Total Cash Receipts		
IV Capital Sales		
Land		
Buildings		
Machinery, etc.		
Total Capital Sales		
Total Sales		

Farm Rental Arrangments

The most common basis for the rental of crop land in the Prairie Provinces is the conventional division of the crop between landlord and tenant. Out of his one-third share, the landlord pays taxes and other expenses for upkeep of his real estate, together with costs of maintenance of his property and his interest. The tenant pays all the other expenses of crop production, including labor and equipment, out of his two-thirds share of the crop.

Lease Principle and Calculation

Leasing arrangements for land represent a pooling of resources by the landlord and the tenant. In general, an equitable distribution of the proceeds of gross farm income would return a share to the landlord and the tenant that is in proportion to their contributions to the expenses of the production of the crops. The conventional one-third, two-third, leasing arrangement would thus reflect a situation where the landlord's contribution was equal to about one-half that of the tenant.

While the principle of sharing returns in the same proportion as costs are contributed is easy to recognize, there are certain difficulties in measuring these contributions when they take the form of land on the one hand, and labour and cash on the other. The first requirement in comparing the contributions of the landlord and the tenant is that both must be reduced to an annual basis. These contributions may then be set out and used as a basis for dividing gross receipts.

The land may be given an annual value by allowing for a return of interest on the investment, based on current rates and a fair valuation of land and buildings. The price for comparable land in the district provides the best evaluation, and the rate of interest should be equal to that received from land mortgages.

The tenant under this one-third, two-thirds, rental arrangement, provides the labour, machinery and cash operating expenses. These factors must be given an annual valuation which may be compared with the allowance for interest made to the landlord. The value of labour may be judged from the current rate of farm wages. The necessary cash expenses are a matter of record-keeping. The valuation of the machinery is more difficult, since both interest on investment and depreciation must be considered. Values of farm machinery may be set in relation to local prices at auction sales and from dealers. An allowance for interest is first credited to the tenant on account of his machinery. Allowance for depreciation, are not easily determined and no fully satisfactory standards are available. These rates should have a close relation to the lifetime of the machines and are often set too high by underestimating this lifetime. For ordinary equipment on Prairie farms, the following may serve as guide; special equipment (truck, tractor and combine), 15 percent; all other machinery, 10 percent.

When the landlord's and the tenant's respective contributions have been determined in this way, they can be set down in a simple account as in Table I, to show the proportion in which these costs are shared by each and to serve as a guide for the sharing of gross income.

In practice, the division of costs will not be exactly in the one - third, two - thirds, ratio mentioned. A tenant may have more equipment than is necessary. Giving him a full allowance for this equipment in calculating his contribution and claim on the proceeds, would result in an unfairly reduced share for the landlord.

(Table 1)

HYPOTHETICAL CONTRIBUTIONS OF LANDLORD AND TENANT IN LAND RENTAL AGREEMENT

(where the landlord supplies the land and the tenant the machinery and expense)

Landlord		Tenant	
Land: Interest on $15,000.00 at 6%	$ 900.00	Labour, 5 mo. at $150.00	$ 750.00
Taxes	300.00	Machinery:	
Other Expenses	50.00	Interest on $4,000.00 at 6%	240.00
		Depreciation:	
		$3,000.00 at 15%	450.00
		$1,000.00 at 10%	100.00
		Cash Expenses	960.00
Total	$1,250.00	Total	$2,500.00

Total Expenses: $3,750.00

Landlord's Contribution: $1,250.00=1/3 3,750.00

Tenant's Contribution: $2,500.00=2/3 3,750.00

Farm Price Cycles

A farmer's main concern is the market price when he is ready to sell. All farmers have had experience with rising and falling prices.

The history of livestock prices does show a quite regular pattern. Cattle prices usually go from a low level to a peak and back again in about ten to fourteen years. With hogs the period is from four to six years. This up and down movement of price corresponds to periods of high and low deliveries of hogs. Livestock prices must relate to deliveries of animals because consumers will not buy an increased amount of meat unless the price is reduced. Prices to producer also must be reduced.

Farmers themselves cause these cycles in cattle prices, by causing the corresponding cycle in production. The farmers decide how much livestock to produce on the basis of current prices. When livestock prices are high farmers increase production. When this increase comes to market the prices fall. In response to low market prices many farmers decide to reduce production. Lower supplies cause prices to rise and the cycle starts again. If farmers could anticipate the price they could make more profitable decisions about how much to produce.

Price outlook information is of great value to the farmer and he should obtain these forecasts and study them even when there is a definite seasonal pattern in livestock prices. High prices correspond with low deliveries and low prices with high deliveries. With hogs the high price usually occurs about August and the low prices about January. The variation in supplies reflects the preference of farmers to produce spring litters. The economy of this practice offsets to some extent the lower price received. A third kind of price movement is the long time rise and fall in the general price level of all commodities. This is the depreciation and boom cycle. In the 30's prices were at a long time low; since World War II prices have been carried upward by general inflation. These price movements are beyond producer control. When other prices (costs) rise faster than the prices of farm products the farmer is caught in the now familiar cost price squeeze.

Farm Credits

The lack of credit is one of the major obstacles encountered by farm managers in farm business adjustment. The business may need to be enlarged, or equipment, buildings, breeding stock or seed may be needed. Following are some credit sources in Alberta which are correct for the present. Private sources have not been included but can be satisfactory.

Table on Sources of Farm Credit

Source	Money may be used for	Interest Rate	Regulations and Stipulations
(1) **Farm Improvement Loans** Handled by chartered banks under a system of federal government backing.	Purchase of farm implements, breeding stock and in the case of land owners to build or alter farm buildings, fences, electrical, heating, plumbing drainage systems, but not for the purchase of land.	5% 5% with	Principle occupation must be farming. The maximum loan at any one time is $5,000. Loans may be for 60% of the cost of second hand equipment, construction or improvement. Terms of repayment depend on the size of loan, but for farm implements, the maximum is three years. Maximum on some of the other loans is 10 years. Security in most cases is taken on the purchased item only.
(2) **Canadian Farm Loan Board** Financed and administered by Federal Government agencies. Alberta head office at Edmonton.	Land purchase, improvements, equipment and production items considered essential to the operation of the farm, and for the consolidation of debts.	5½% on arrears	Principle occupation must be farming, and farm must be owned, or under purchase agreement. Evidence required of ability to repay. Maximum loan is presently $15,000 or not more than 65% of appraised productive value of farm. Security is first mortgage on land owned, or to be purchased. Terms up to 30 years.
(3) **Veterans Land Act** Administered and advanced by the VLA Department of the Federal Government to veterans only.	To purchase land, buildings, materials, livestock and farm equipment.	3½% on initial loan, plus 5% on supplementary loans.	The borrower must be a veteran with certain minimum service requirements and who has passed a screening board with regard to his suitability as a farmer. Briefly, $6,000 is the maximum loanable under part 1 of the Act for the purchase of land, livestock and equipment. Ten percent down payment is required. In addition, under part 3, another $3,000 at 5% can be borrowed. Loans must be paid back over a period not exceeding 25 years. In the case of the loan under part 1 certain fulfilled contract requirements by the farmer cuts down the amount he must repay. Under part 3, the full $3,000 is repayable. VLA holds title to the property, while the veteran repays the loans under the supervision of VLA fieldmen.

Source	Money may be used for	Interest Rate	Regulations and Stipulations
(4) **Credit Unions** Incorporated under the cooperative Activities Branch, Department of Industries and Labor, Alberta Government. Money from depositor members.	Personal as well as business items.	1% per month on the unpaid balance for small loans, and ½% per month on loans over $200.	Maximum to a borrower depends on reserves of the credit union, security offered, and ability to repay. Stipulations set by Credit Union's board of directors. Usually short term to intermediate. Security may include real estate, securities or chattels.
(5) **Farm Purchase Credit Act** Processed through a Farm Purchase Board set up by municipal by-law and agreement with the Provincial Treasurer	Purchase of land to establish economic farm units, and at the same time to provide a substantial down payment to the seller.	5%	Purchaser pays down 20%. Government pays approximately 40% or a maximum of $7,500 which gives the seller about 60% of the selling price. Paid over a period up to 20 years, provided payments do not go beyond the borrower's 66th birthday. If the existing farm is worth $25,000 or more, a loan will not be granted.
(6) **Bank Loans** Chartered Banks and Treasury Branches.	Operating capital and other transactions of a short term nature. For land purchases by way of mortgages.	Presently about 6%	Security may be bonds, other securities, real estate, but not usually chattels. Payments to suit farmer's production cycle, but most short term.
(7) **Insurance, Trust and Mortgage Companies**	Purchase of real estate.	Varies	These companies have largely withdrawn from mortgage loans on land but may loan on superior quality land.
(8) **Merchant, dealer, and finance companies**	Supplies, equipment bought both for business and personal.	Range from 10% to 25%.	Obtained directly or indirectly through dealers wishing to sell their product, or through loan companies set up strictly to make money loans. High interest rates, loan usually easily obtained, without embarrassment and often with little or no tangible security.
(9) **Agricultural Processors and Feed Companies**	Production of some farm commodity.	Competitive with bank interest.	Contract integrating farmer and processor. Product usually goes to the contracting processor. In the case of a feed company, the farmer must use its feed.

Source	Money may be used for	Interest Rate	Regulations and Stipulations
(10) **Feeder Associations** Set up under Cooperative Associations Act. Operate under Feeder Ass'ns. Guarantee Act. Administered by Livestock Branch, Alberta Dept of Agriculture.	Purchase of feeder cattle and lambs.	Presently about 5%	Association maximum $100,000 with limits for individual may borrow, usually about $4,000. No breeding stock may be purchased. Provincial government guarantees loaning institutions against losses up to 25%. Feeder associations operate best in livestock feeding district.

Beween the farmer and consumer are the processor, the wholesaler and the retail store, each an independent operator. Whenever two or more of these separate operations are combined under one management, it is described as vertical integration. Control may be exercised through ownership of farms where vegetable canners grow their own vegetables, or it may be exercised through a contract between processors and growers.

Vertical integration has its roots in the retail store. The consumer is interested in a steady supply of his favorite foods at a stable price. The chain store with large volume caters to consumer preferences.

Peak seasonal production is not consistent with steady supply. To ensure this uniform supply, processors with assured retail outlets contract with producers to the ends that economies are effected by both.

Integration Advantages

The advantages may be summarized as follows:-

1. Production is more closely regulated to demand.
2. Growers and processors achieve lower costs through large scale production and steady operations.

Arrangements between growers, processors and retailers may take many forms. In some cases one firm may become the outright owners of businesses either above or below them in the production-marketing chain. In others the basis may be a contract between the two independent operators. Contracts also may differ specifying any or all such items as quantity, price, credit arrangements and supervision. The advantages of integration depend on the terms of the contract and each contractor must consider his own best interests.

In Alberta integration is largely confined to poultry and the broiler business so far. However contract production of other products is not new. Catt'e have been fed under contract and large acreages of certain field seeds and other specialty crops have been under contract. Contracts seem most suitable for products that can be sold in large volume by retail stores, mainly meat products, with seasonal variations in production. Secondly contracts for production can only be fulfilled with certainty where production can be conducted in factory type operation. This seems to rule out grain production, where uncertainty not only makes it impossible to ensure a given volume, but also involves the risk of financial los . This risk makes crop production unattractive to any investor who might otherwise consider integration. Finally there is the difficulty of management of a large crop program. Managerial problems multiply with space and eventually become a limiting factor.

The development of vertical integration seems to follow the tendency of farm production to become specialized. The mixed farmer is being forced by competition to specialize in those products to which his situation is best suited. In this process he is dropping off his side enterprises and these are being picked up by other specialists. The same forces of competition also are causing the farm business to become larger, to enable the operator to obtain a required standard of income. To the extent that "vertical integration" contributes to these two tendencies they will no doubt become part of the changing organization of farms and business.

SOME FARM MANAGEMENT TERMS

A FARM ENTERPRISE is a branch of the farm business, such as a crop or a class of livestock.

COMPETITIVE ENTERPRISES require the use of one or more of the farmer's productive resources at the same time and thus tend to limit each other. e.g.: (Grain and Hay)

SUPPLEMENTARY ENTERPRISES fit together without serious conflict in the use of resources. e.g.: (Grain production and Beef feeding).

COMPLEMENTARY ENTERPRISES are contributory, each to the other, in the use of resources. e.g.: (Dairy cows and hogs).

INTENSIVE FARMING is farming in which comparatively large amounts of labor and working capital are used per acre of land.

EXTENSIVE FARMING is farming in which comparatively small amounts of labor and working capital are used per acre of land.

FIXED FARM CAPITAL is the land with such permanent improvements as are ordinarily transferred with the title of the land.

WORKING FARM CAPITAL is the livestock, equipment, feed,(other supplies and cash used in the operation of the farm business.

GROSS FARM INCOME is the sum of the annual receipts from sales, miscellaneous farm receipts, increase in farm inventory, and the value of living from the farm furnished to the operator, his family, and hired laborers.

FARM EXPENSES is the sum of the annual cash operating expenses, value of unpaid family labor, decrease in farm inventory, depreciation, and the value of living from the farm furnished to hired laborers.

NET FARM INCOME is the compensation, including the value of family living from the farm, for farm capital and labor and management. It is derived by deducting farm expenses from gross farm income.

NET FAMILY FARM INCOME is the compensation, including the value of family living from the farm capital, labor and management and labor of unpaid members of the operator's family. It is derived by deducting farm expenses, exclusive value of unpaid family labor, from gross farm income.

OPERATOR'S EARNINGS is the compensation, including the value of family living from the farm, for operator's labor and management. It is derived by deducting an interest charge for the use of farm capital from net farm income.

FAMILY EARNING is the compensation including the value of family living from the farm, for operator's labor and management and for labor of unpaid members of the operators family. It is derived by deducting an interest charge for the use of the farm capital from net family farm income.

FARM CAPITAL EARNING is the compensation for farm capital. It is derived by deducting the value of the operator's labor from net farm income. If expressed in percentage, it should be designated (per cent earnings of Farm capital).

UNPAID FAMILY LABOR is labor, used in the farm business, by the members of the farm family, other than the operator, for which no wage is paid. Its value is determined on the basis of the amount of additional labor the operator would have to hire at current wages to carry on the same size of business had the family labor been not available.

MAN EQUIVALENTS is the total months of labor, including the operator, divided by 12.

AN ANIMAL UNIT is one mature horse or cow, or the equivalent in other livestock, based upon the amount feed consumed, manure produced, or other appropriate conversion factors.

CROP YIELD INDEX is a percentage ratio of the yield per acre of the same crop or crops of a group of farms. If more than one crop is included in the index, the yield of each crop is weighted by acres, man work units, or some other measure.

LIVESTOCK INDEX is a comparative measure of production or returns per animal, or unit of feed fed, of one or more classes of livestock on a given farm or group of farms, expressed as a percentage of some specified base.

DIVERSITY INDEX is a measure of the number and relative sizes of farm enterprises in the farm business.

Agricultural Services

Alberta Department of Agriculture

Administration—The Deputy Minister is responsible for general direction and administration of policy, personel, accounting, etc.

Assistant Deputy Minister—administers The Land and Forest Utilization Act and generally assists The Deputy.

Extension Branch—District Agriculturists Division—a supervisor provides detailed administration and supervision of District Agriculturists who assist farm people with information on all phases of farm management and husbandry. Home Economics Division — District Home Economists are supervised and directed by a supervisor in assisting farm people in all matters pertaining to the home. Subject matter specialists also are attached to this division. District Agriculturists and District Home Economists are responsible within their districts for organization and supervision of 4-H Clubs.
Statistics Division—collects, compiles and publishes statistical information on agriculture, including crop reports.

Agricultural Engineering Division—Agricultural Engineers assist farmers directly and through District Agriculturists. Farm Management Division—Specialists for District Agriculturists and farmers assistance. Extension also administers Agricultural Societies, Names of Homes Act, Farm Labour and The Farm Water Assistance Policy.

Field Crops Branch—responsible for providing services to those engaged in crop production, horticulture and apiculture. For administrative purposes there are five principal divisions within the Branch, namely, Crop Production and Improvement; Soil Conservation and Weed Control; Crop Protection and Pest Control; Horticulture and Apiculture. Each is administered by a Supervisor, who is responsible to the Commissioner. In addition the Branch is charged with the operation of the Horticultural Station at Brooks and the Tree Nursery at Oliver.

The Branch, through the Supervisors and Fieldmen, administers legislation relative to the various phases of crop production, develops and implements policies to guide the courses of production and endeavors to keep informed on research and experimentation as applied to production. The Supervisors serve as Specialists through the District Agriculturists.

Livestock Branch—Administers Acts and policies under which the following activities are governed: brand inspection and registration, licensing of butchers and hide dealers, licensing and bonding of livestock dealers and agents, licensing of auction markets and stockyards, pounds or herd law in Local Improvement Districts, pure bred sire areas, Alberta livestock exhibit to the Royal Winter Fair, the Horned Cattle Purchases Act, the Cattle Improvment (bull) policy, the Swine Improvement (boar) Policy, the Sheep Improvement (ram) Policy, the 4-H Dairy Heifer Calf Policy, the artificial insemination policy, the livestock feeder's associations, specialized livestock extension, general livesock improvement promotion, investigation of stock losses and trade practices.

Dairy Branch—Administers leglislation dealing with dairying, frozen food locker plants and margarine. The services available include: Dairy herd improvement programs, laboratory control service for dairy plants, mastitis control program for dairy herd owners, inspection and instruction for dairy and frozen food locker plants, production cost studies on different types of farms and specialist assistance to extension workers.

Radio and Information Branch—Present daily the ten-minute radio program Call of the Land over a province-wide network, and maintains a flow of timely information in the weekly press releases Farm Notes and Science and the Land.

Poultry Branch—Administers Acts and policies with respect to: flock approval; turkey approval; licensing and bonding of hatchery operators, egg grading stations and poultry processing plants; Alberta Random Sample Test; the poultry associations (hatching egg shippers, turkey breeders, hatchery, and produce); specialized poultry extension; general poultry production improvement promotion; investigation of poultry losses and trade practices.

Schools of Agriculture and 4-H Club Branch—Under the Agricultural Schools Act several schools are established and directed by the Department offering vocational training in Agriculture for boys and in Home Economics for girls. Schools are located at Olds, Vermilion and Fairview.

Individual clubs are organized and supervised by the District Agriculturists and District Home Economists while over-all direction is provided by the 4-H headquarters staff.

Fur Farm Branch—Administers the Fur Farm Regulations and assists the fur farmers with information on ranch management, nutrition, genetics and disease.

Canada Department of Agriculture

Assistance is available in the fields of research, production and marketing, and special assistance such as the Prairie Farm Rehabilitation Act and the Prairie Farm Assistance Act. Four experimental farms and three research laboratories are operated by the Department. The soil survey is carried on co-operatively with the Provincial Government. Regulatory and promotional activities carried on by the Production and Marketing Branch involve the grading and inspection of agricultural products, animal disease control, regulation of trade in seeds, feeds and fertilizers, performance testing of livestock and poultry, and financial assistance toward the promotion of better agriculture. Water conservation and community pasture development are examples of conservation activities carried out under the Prairie Farm Rehabilitation Act, while the Prairie Farm Assistance Act provides for a measure of assistance to farmers in crop failure areas.

Regional headquarters for the various units are shown hereunder. The Health of Animals Division is concerned with meat inspection at inspected slaughtering plants, and with the control and eradication of animal diseases. Fruit and Vegetable and Dairy Products Division officers are concerned with the inspection and grading of these products. The Livestock Division is responsible for the grading of livestock products and for the operation of policies designed to improve livestock quality. The Plant Products Division promotes the development and use of better seed, and regulates the trade in seeds, feeds and fertilizers. The Poultry Division is responsible for the grading and inspection of eggs and poultry, and for the administration of the national poultry policies. Under the Plant Protection Division is certified seed potato work and the administration of legislation designed to prevent the entry of foreign plant diseases and insect pests. The Economics Division, now associated with the Administration Branch of the Department, maintains a regional office in Edmonton.

RESEARCH BRANCH

Beaverlodge—Experimental Farm
Field and horticultural crops, livestock, apiculture, and soils.

Calgary—Forest Biology Laboratory, 102 11th Avenue East.
Insects and diseases affecting trees and shrubs and their control.

Edmonton—Plant Pathology Laboratory, University of Alberta.
Cereal and forage crops diseases and their control. Alberta Soil Survey, University of Alberta. Pedology and soil survey.

Fort Vermilion—Experimental Farm: Field crops and livestock.

Lacombe—Experimental Farm
Livestock and poultry breeding and nutrition, field and horticultural crops, and soils.

Lethbridge—Research Station
Irrigated and dry land agriculture involving livestock, field and horticultural crops, livestock nutrition, wool research; insects and diseases affecting field and horticultural crops and their control; insects affecting livestock and their control.

Manyberries—Experimental Farm: Livestock breeding and range management.

Stavely—Range Experimental Substation: Range management.

Vauxhall—Irrigation Substation: Consumptive use of water and related soil problems.

Vegreville—Experimental Substation: Problems with solonetzic soils.

PRODUCTION AND MARKETING BRANCH

Brooks
Fruit and Vegetable Inspector ..... P.O. Box 370

Calgary
Dairy Products Division Office ..... Northern Electric Building
Fruit and Vegetable Division Office ..... Northern Electric Building
Health of Animals Division District Veterinarian 403 Public Building
Sub-District Office ..... Northern Electric Building
Stockyards Office ..... 302 Livestock Exchange Building
Livestock Division Office ..... Northern Electric Building
Stockyards Office ..... c/o Alberta Stockyards

Plant Products Division Sub-District Office	Northern Electric Building
Chemical Laboratory	Northern Electric Building
Poultry Division Office	Northern Electric Building
Retail Store Inspection Office	Northern Electric Building
Camrose	
Health of Animals Division Sub-District Office	Federal Building (Box 1150)
Coutts	
Health of Animals Division Sub-District Office and Quarantine Station	Customs and Immigration Building (Box 143)
Drumheller	
Health of Animals Division Sub-District Office	Post Office Building (Box 124)
Edmonton	
Dairy Products Division District Office	882 Federal Building.
Fruit and Vegetable Division Office	Federal Building
Health of Animals Division Sub-District Office	762 Federal Building
Livestock Division District Supervisor	Federal Building
Stockyards Office	Edmonton Stockyards
Plant Products Division District Supervisor	868 Federal Building
District Analyst	845 Federal Building
Plant Protection Division Office	
Plant Inspection and Seed Potato Certification	820 Federal Building
Poultry Division Office	899 Federal Building
Retail Store Inspection Office	Federal Building
Grande Prairie	
Plant Products Division Office	Post Office Building (Box 3117)
Lethbridge	
Fruit and Vegetable Division Office	309 Post Office Building
Health of Animals Division Sub-District Office	401 Post Office Building
Veterinary Research Laboratory	
Livestock Division Office	Alberta Stockyards
Plant Products Division Office	Post Office Building
Plant Protection Division Office Plant Inspection and Seed Potato Certification	311 Post Office Building (Box 55)
Medicine Hat	
Health of Animals Division Sub-District Office	Post Office Building
Peace River	
Health of Animals Sub-District Office	102 Federal Building (Box 876)
Red Deer	
Health of Animals Division Sub-District Office	217 Public Building
Plant Products Division Office	212 Public Building
Poultry Division Office	214 Public Building
Vermilion	
Health of Animals Division Sub-District Office	3 Heckbert Building (Box 1791)
Wetaskiwin	
Health of Animals Division Sub-District Office	Bank of Montreal Bldg (Box 1016)

SPECIAL ACT ADMINISTRATION

Prairie Farm Rehabilitation Administration — P.F.R.A. .... Vauxhall

Prairie Farm Assistance Administration — P.F.A.A. ..... Federal Building, Edmonton

Registration of Purebred Animals

Correspondence concerning the registration of purebred animals of all breeds, Holstein-Friesian excepted, should be sent to the Accountant, Canadian National Livestock Records, Department of Agriculture, Ottawa; for the registration of Holstein-Friesian Cattle to the Secretary, Holstein-Friesian Association, Brantford, Ontario.

University of Alberta

Department of Agricultural Engineering — Information on farm power and machinery, farm buildings and services, handling and storing agricultural materials.

Department of Animal Science — Information on the care, feeding, breeding, and management of farm livestock and poultry.

Department of Dairying — Information on the handling and processing of milk and milk products; the principles involved in food processing. Bacteriological and chemical problems in handling and preserving foods, etc.

Department of Entomology — Information on the identification and control of insects.

Department of Plant Science — Information on farm crops and varieties; weed identification and control; horticulture including vegetable varieties and gardening, fruit and flower growing, horticultural pests, landscaping, etc.

Department of Soil Science — Information on soil fertility; use of commercial fertilizers, barnyard manure, straw, stubble, etc.; use of mineral soil amendments (gypsum, lime, etc.); crop rotation; improvement and fertilization of soils for lawns and gardens; soil erosion; irrigation; soil salinity ("alkali"); inoculation of legumes; soil survey information, etc.

Agricultural Soil and Feed Testing Laboratory — This laboratory, on the Edmonton campus, is financed largely by the Alberta Department of Agriculture. Alberta farmers, home owners, and greenhouse operators may submit soil samples for testing; only unmixed samples of farm-grown feeds are accepted for analyses. Recommendations based on the tests performed are sent to those submitting samples.

Instructions and sample containers are available from the Laboratory or from District Agriculturists.

Department of Extension: Distribution of agricultural circulars and bulletins written by University staff members; up-to-date lists of agricultural pamphlets and bulletins available from major sources in Canada and the United States: advisory service on community leadership and community activities; provision of speakers upon request; film library with extensive coverage of both agricultural and other topics; Extension Library service through open shelf borrowing, travelling libraries; Extension Specialists in Music, Art and Drama for classes in rural points; arrangement of short courses, classes and conferences both on and off campus.

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